THE

POPULAR SCIENCE MONTHLY.

OCTOBER, 1883.

MATTER LIVING AND NOT-LIVING.

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THE Victoria Institute, or Philosophical Society of Great Britain, has published, in pamphlet form, a paper by Professor Lionel S. Beale, in which that eminent physician and microscopist attacks, with free assertion and aspersion, the doctrine of the identity of living and not-living matter. Dr. Beale is himself a member of the Victoria Institute, and, if one may judge from the *imprimatur* which the society has set on his paper, he is esteemed a spokesman worthy of its name, if not a foeman worthy of anybody's steel; and no doubt the paper has proved acceptable to those for whom it was intended. It may be worth while, therefore, in the interest especially of this excellent class, to examine what he has to say.

Dr. Beale, it might better be mentioned at once, has a theory of his own, or at least of his adoption, with which he confronts the theory of his aversion; and it will conduce to clearness, as well as brevity, if we first look at the opposing theories side by side, premising that Dr. Beale expressly lays the question of their relative merits before the tribunal of science, whose jurisdiction in the case he thereby acknowledges. Let us at the outset, then, regard the two theories as he sets them face to face.

Dr. Beale opens the discussion by confessing that he finds himself among the "very small number" who "have objected to the physical view of life as untenable *in the present state of scientific knowledge*," a qualification which in the course of his paper he repeats and reiterates, and which means, if it means anything, that the capacity of physical causes in this relation has not yet been explored exhaustively, and that the view in question may become tenable in the progress of scientific knowledge. "The living world," Dr. Beale proceeds to say, in the

face of this significant admission, "is absolutely distinct from the non-living world, and, instead of being a necessary outcome of it, is, compared with the antiquity of matter, probably a very recent addition to it—not, of course, an addition of mere transformed or modified matter and energy, but of transcendent power conferred on matter, by which both matter and its forces are controlled, regulated, and arranged, according, it may be, to laws, but not the laws of inert matter." This additional agent is, of course, our old acquaintance—the *vital force.* Dr. Beale adds: "It may be freely admitted that, if we attribute to vital power certain phenomena of the living world which have not been, and can not be, explained or accounted for by any physical laws yet discovered, we thereby assume an agency which we are unable to isolate or demonstrate, and the existence of which we can not in any way prove. On the other hand, it is only fair to observe that, if we assume that phenomena peculiar to life will some day be explained by physics, we certainly act in a manner which is not sanctioned by science—we assume, we prophesy; and prophetic assumptions of every kind are contrary to the spirit of science. . . . But is it not in accordance with reason," he concludes, "to assume the existence of a peculiar power to account for phenomena which are peculiar to living beings, which differ totally from any known physical phenomena, and which can not be imitated—and is it not contrary to reason to prophesy that such phenomena will one day be explained by ordinary forces or powers?" Such is his statement of the case, and such the argument by which he supports his side of it.

A few words, I think, will suffice to show the invalidity of the argument. The question, fortunately, hinges on a point which science has determined definitively.

A genuine hypothesis, in the scientific sense, is capable of proof or disproof; for an hypothesis capable of neither must always remain an hypothesis, and, instead of leading to an explanation of phenomena, serves to block the way to it. I may say here, parenthetically, that too much verbal respect, as it seems to me, is usually paid by scientific thinkers to assertions of this transcendent sort; strictly speaking, an assertion, of which it is said that it can be "neither proved nor disproved," is disproved by denying it, for the denial, being of equal validity with the assertion, nullifies it, leaving zero as the logical result, and an assertion reduced to zero is effectually disproved. But to return. An unverifiable hypothesis, as incompetent to lead to certainty, has no reason of being; and, consequently, science pronounces it illegitimate. But the hypothesis of a *vital force,* Dr. Beale admits, is unverifiable. It assumes "an agency," he owns, "which we are unable to isolate or demonstrate, *and the existence of which we can not in any way prove.*" It is, therefore, illegitimate on his own showing.

Moreover, a genuinely scientific hypothesis does not assume an unknown cause, much less an unknowable one, before the inadequacy of

known causes has been proved, for, till then, the necessity of an additional cause can not appear. The maxim which imposes this condition on hypotheses, known in philosophical literature as Occam's razor, is declared by Sir William Hamilton, who calls it the law of Parcimony, to be "the most important maxim in the regulation of philosophical procedure, when it is necessary to resort to an hypothesis." Its soundness is questioned by no one. But Dr. Beale, as we have seen, admits by plain implication, repeatedly, that known causes have not yet been proved inadequate to explain the phenomena of life. His cautious statement is that they are inadequate "*in the present state of scientific knowledge.*" Wherefore, as he must also admit, his assumption of a hyperphysical agent violates flatly the law of Parcimony; it falls under the first stroke of Occam's razor. It is thus doubly illegitimate, on his own showing.

Finally, the hypothesis, if admitted, would not explain the phenomena, since it merely refers them to a power of which confessedly we can know neither the existence nor the laws, assuming to explain that which we do not know now by that which we can never know or so much as represent in thought; and it goes without saying that an hypothesis which explains nothing is good for nothing. In branding it with illegitimacy, science but renews the stigma that common sense had set on it.

The hypothesis, it follows, has no standing in the court of science, which rules it out at the threshold; and to the court of science, be it remembered, Dr. Beale has appealed. One thing, then, is certain: whatever may be the merits or demerits of the hypothesis which he opposes, the hypothesis which he espouses has no merits at all. It is radically vicious, and wholly inadmissible. So far from being "in accordance with reason," it is in flagrant defiance of it.

It remains to inquire into the remaining hypothesis. If we may credit Dr. Beale, it is as spurious as his own. "If we assume," he tells us, "that phenomena peculiar to life will some day be explained by physics, we certainly act in a manner which is not sanctioned by science—we assume, we prophesy; and prophetic assumptions of every kind are contrary to the spirit of science." That depends on the character of the assumptions. If, like his hypothesis, they are incapable of proof or disproof, besides gratuitously multiplying causes, and explaining nothing after all, they undoubtedly are contrary not only to the spirit but to the letter of science; but, if they fulfill the conditions of a legitimate hypothesis, in lieu of violating them at all points, as his own assumption does, they as undoubtedly are in strict harmony with science. It would be passing strange if they were not. If "prophetic assumptions of every kind" were in truth "contrary to the spirit of science," that "star-eyed" creature would be more contrary than the privilege of her sex allows, for it is by "prophetic assumptions" that she has won her chief triumphs, nearly everything

which is now certainty having once been assumption. When Copernicus divined that the planets revolve around the sun; when Kepler suggested that the planetary orbits are ellipses; when Newton proposed the law of gravitation, and, later, the identity of gravitation with the central force of the solar system; when Huygens conjectured that light is propagated by undulations; when Harvey, in the profession of which Dr. Beale is an ornament, supposed that the blood flows from the left side of the heart into the right through the arteries and veins; when Locke asserted that heat is motion; when Franklin assumed that lightning and electricity are one; when Dalton affirmed that elements combine in definite, reciprocal, and multiple proportions; when Leverrier announced the existence and position of a planet outside the orbit of Uranus; when Faraday conceived the principle of definite electro-chemical decomposition—they each and all indulged in what were "prophetic assumptions," until in due time the assumptions were proved and the prophecy accomplished. And so, for the most part, with the rest. Wherever, indeed, there is an inquisitor of nature, whether observer or experimenter, there is likely to stand behind him some hypothesis, more or less shifting, more or less defined, more or less probable, which guides his inquiries and shapes their results; and what is generally true of the experimental sciences is true in greater degree of the sciences in which experiment is impossible or possible only within a narrow range, such as astronomy, biology, psychology, sociology. The truth is, without "prophetic assumptions," science would need either omnipotent insight, to see through every problem at once, or that omnipotent blindness which enables its happy possessor to solve every problem, as Dr. Beale would solve the problem of life, by referring it out of hand to some agency beyond the bounds of human knowledge; but, as science is endowed with neither, it has, in general, no other course, certainly no better course, than to proceed tentatively by "prophetic assumptions," careful only, though rigorously careful, that these shall fulfill the acknowledged conditions of a legitimate hypothesis. As for such "assumptions" as Dr. Beale's, they are not "prophetic," it is true, but only because they forever renounce the hope of explanation. Science rejects them, as we have seen.

Let us see whether or not the hypothesis of the evolution of living from not-living matter encounters the same fate.

To begin with, the hypothesis, it will not be denied, is verifiable, for it assumes only a certain competency in the properties of matter, which, if it exists, is capable of proof under possible conditions, and, if it does not exist, is capable in like manner of disproof; so that in the end the assumption must lead to certainty or step down and out. Such being the case, it fulfills the first condition of a legitimate hypothesis.

The hypothesis, in the next place, assumes no special cause, known

or unknown, physical or hyperphysical, but accepts that which, by universal consent, is not only the cause of inorganic phenomena, but the invariable concomitant, if not the cause, of the phenomena of life. It does not multiply causes with or without necessity, and hence is philosophically clear and clean. Occam's razor may pass over and around it without meeting with a pilous stub.

And, lastly, inasmuch as the assigned cause is real, and as the final verification of the hypothesis must consist in deducing the phenomena from it, the hypothesis, when verified, will of necessity explain the phenomena not merely in their completeness, but to the exclusion of all other explanations. It is one of those fortunate cases, not too common in the history of science, wherein the explanation of the phenomena is the demonstration of the hypothesis.

In the judgment of science, therefore, the hypothesis as such is without spot or flaw. So far from being "contrary to reason," it is in perfect accord with it.

From all of which it appears that the converse of Dr. Beale's opinion of the two hypotheses is true. His terms of praise and dispraise were well chosen, but, as it turns out, he mixed them badly before applying them. So much for the opposing theories as theories.

Having seen that, from the scientific point of view, the hypothesis which Dr. Beale espouses is thoroughly illegitimate, and that the hypothesis which he opposes is thoroughly legitimate, we have now to look at the existing evidence in support of the latter; and here we shall strike Dr. Beale's criticisms, for here their incidence logically falls. With how much force they fall we shall presently see.

When two series of phenomena shade off into each other by insensible gradations, the philosophical presumption is that both series have been generated by one cause; and it behooves him who would overcome this presumption to draw the line of demarkation between the series, and prove that the phenomena on the opposite sides are so different that they could not have had a common origin. Organic and inorganic phenomena, I need not say, thus shade off into each other; but no one has been able, though many have made the attempt, to draw a line of absolute demarkation between them, much less to prove that the two series, as arbitrarily distinguished from each other, must have proceeded from different causes. Toward the proof of this the first step has not been taken, and it is safe to say that it never will be; it is barred by the indissoluble continuity of natural law. Meantime the presumption stands in more than its original strength.

A kindred presumption, throwing a kindred burden on the shoulders of whoever would rebut it, is the presumption that causes which increase an aggregate are competent to originate it. The forces which determine the growth of a crystal, to exemplify, are the forces which produce its embryo; and the like holds true of all other aggregates below the vital ones. Why not of these also? The forces which

determine the growth of a plant or animal are physical forces; any assumption to the contrary, remember, even Dr. Beale avows that "we can not in any way prove." Why can not physical forces, in this case as in others, originate what they develop? It is for him who denies that they can do both or either to show why. This has never been done; and, till that which Dr. Beale admits to be unprovable is proved, never will be. The denial is a bald negation, leaving the presumption to stand, like the allied one, strengthened by a fruitless contradiction.

But we are not left to philosophical presumptions, insurmountable though they are. The evolution of living from not-living matter, it should be borne in mind, is an essential part of the hypothesis of evolution at large, and shares evenly in all the evidence, direct and indirect, which supports the general hypothesis, and which, against rooted predispositions of every kind, and amid the continual uproar of detraction and abuse, has revolutionized the thought of our time, putting Dr. Beale and his school of thinkers, but lately in an overwhelming majority, in a minority that he fairly terms a "very small number," and taking the chair of authority, as he ruefully complains, not simply in the laboratory and the closet, but in the study and the school, and, he might have added by "prophetic assumption," the Church, that loving mother of most of us beginning dimly to perceive that evolution founds science and religion on the self-same basis, and, in place of being the enemy of either, is the truest friend of both. The evidence which, in the course of a single generation, has wrought this marvelous change in unwilling minds, and the more distinctly in the higher minds, goes in its full strength, I repeat, to support the special hypothesis in hand. Manifestly, the leaders of thought, in both hemispheres, estimate this evidence differently from Dr. Beale. It is truly irresistible to an open and enlightened mind.

Furthermore, the earth, we should not forget, is her own biographer; and in the geologic chapter of her authentic sketch is recorded a time when life did not exist within her limits. Life on the earth had a beginning, then. This is not denied. Nor is it denied that up to the beginning of life all terrestrial phenomena were the effects of physical forces.

So much is conceded by every one, Dr. Beale not excepted. And, now came life. Whence did it come? Whence does it come? Physical forces, undeniably, are the constant antecedents of life; which, moreover, varies in fixed correspondence with determinate variations in them. This Dr. Beale must likewise concede, or assail the foundations of his art. But it is an axiom in scientific inquiry that anything, upon whose variations the variations of an effect are uniformly consequent, is the cause or connected with the cause of that effect; and, since the physical forces accompanying life are connected with no other cause except the Ultimate Cause, it results that they

are the proximate cause of life—the only cause, that is to say, which the human intellect can grasp, and with which accordingly science has to reckon. If we reject this conclusion, we reject with it the methods of science, and along with these science itself. But science is our chosen arbiter.

Nothing in reality is lacking to crown the hypothesis with demonstrative proof but to discover the law of co-operation of the physical factors uniting in the production of life, and deduce the phenomena from it; although to furnish this may well tax the highest resources of science for an indefinite future. And yet some happy feat of induction or deduction, or of both combined, may furnish it to-morrow. Meanwhile, the hypothesis as it stands, it is hardly too much to say, exacts the acquiescence, if it does not secure the assent, of every mind at once unbiased and not uninformed. The cause of life is known. The law of the cause alone is unknown. This law, as to which no hypothesis has yet been formulated, is strictly the only aspect of the subject open to hypothesis; so that, while the hypothesis supplied has passed beyond the hypothetical stage, the hypothesis required has not definitely reached it. In this logical interregnum, however, the vacating hypothesis, obviously, must still rule the discussion. But let us hear Dr. Beale.

"Bear in mind," he admonishes us, "that no state of matter known, no mere chemical combinations, no mechanical contrivances, no machinery ever made, can be caused to exhibit phenomena resembling in any really essential particular those which are characteristic of every form of living matter that exists in nature." This admonition may be just, and I am disposed to think it is, if qualified by that reference to "the present state of scientific knowledge" which the learned professor often makes, but which he here apparently fails to "bear in mind"; yet, with this qualification, it is not indisputably just, seeing that Dr. Bastian, one of the foremost experimenters of the age, contends that he has surmounted the difficulty which Dr. Beale declares to be an impossibility. Whether Dr. Bastian has achieved this result or not, the impossibility of achieving it has not been proved; on the contrary, the possibility, with the advance of scientific knowledge, has grown clearer. A few years ago, Dr. Beale might, with equal justness, have delivered this same admonition to us in respect to organic compounds of every sort; but meanwhile chemistry, in the face of the assumed impossibility of making any of them, has, in fact, made hundreds of them, therein surpassing the creative power even of animal life, which in general is powerless to form them, but appropriates them ready made from the vegetable world, in which they are compounded out of their elements; and, if chemistry can produce organic matter, it may, when further developed, produce organisms, or, what would be of equal significance, formless protoplasm. It is on the way, and pressing forward. While impossibilities, akin to Dr. Beale's pres-

ent impossibility, are falling right and left under the strokes of science, who shall say that this one, too, may not ultimately crumble beneath the strenuous but reverent assault? Whether the achievement is possible or impossible, however, the derivation of life from not-life at some time, if not at this time, under conditions provided in the laboratory of Nature herself, is certain: the fate of the hypothesis is not by any means involved in that of the experiment.

"No specimen of any kind of matter which is actually passing from the non-living to the living state, or which can be shown to establish any connection between these absolutely different conditions of matter," Dr. Beale asserts, "has been, or can be at this time, brought forward." Discounting the expression "absolutely different," and noting with satisfaction the qualifying phrase "at this time," it must be observed that the assertion remains, nevertheless, in some degree inaccurate. Not to mention that all living matter is constituted by not-living elements, there is good reason to believe that the molecules of those colloidal compounds which together form living matter are constituted by molecules of the not-living crystalloids, and it is beyond dispute that the same substance, as silica, may pass, under varying conditions, from the crystalloidal to the colloidal state and back again, for which reasons, among others, the colloid may be pointed to as a "kind of matter" which, if not "actually passing from the non-living to the living state," can at least be said to "establish" some "connection" between these "different conditions of matter." Be this as it may, it "has been brought forward" as such, and by no less honored an investigator than Professor Graham, whose discovery of the law of the diffusion of gases, to say nothing of his profound researches on the diffusion of aqueous solutions, should have made his name familiar to Dr. Beale. "The colloid is in fact," says Professor Graham, "a dynamical state of matter, the crystalloidal being the statical condition. The colloid possesses *energia*. It may be looked upon as the primary source of the force appearing in the phenomena of vitality." Whatever Dr. Beale may think of the colloid, it serves at any rate to check his broad assertion, and at the same time to indicate how sharply experimental science is pressing upon the problem of life. "At this time," however, the pregnant movement has but fairly begun.

"But the fact," Dr. Beale insists, "that this living matter, as is well known, is invariably derived from matter that already lived, is a serious difficulty which presents itself to the mind at the outset of the inquiry." Here, again, our professor omits the important qualification to which he is committed. "Living matter" is "invariably derived from matter that already lived," so far as our experience goes, if we leave out of the account Dr. Bastian's experiments; but our experience at present, aside from those interesting but unfinished researches, does not stretch away to the beginning of life, and it is unphilosoph-

ical to extend a merely empirical law beyond the limits in which it has been found true by observation. It was once believed, for instance, that all swans are white, and, what is more, the belief was sustained by the uniform experience of mankind for thirty centuries; but it turned out to be erroneous, all the same. That the black swan of *archebiosis* has not been seen is no proof that it may not be seen, if we push on to its presumptive haunt by the shaded springs of life; and, in the interval, we can be sure only of what we have positively seen. But of this there of course can be no doubt. The famous maxim, *All life proceeds from life*, is indeed necessarily true of all the more specialized forms of life, because the proceeding of any one of these directly from inorganic matter would necessitate a leap over the intermediate forms; and Nature, as in our day is realized more vividly than before, does nothing by leaps. The maxim, though reached inductively, may be explained deductively; it is itself, thus limited, a corollary from the general law of evolution. But, with forms of life having little or no specialization, and only a few removes or one remove from inorganic matter, the case is plainly different. Respecting these, induction, so far as it has yet gone, and deduction, so far as it can now be applied, agree in pointing unmistakably to their origin in the unorganized matter from which they are scarcely distinguishable, and from which they differ in every respect vastly less than from the more specialized forms arising out of them, and immeasurably less than the human adult differs from the human embryo. Of these lowest forms, exhibiting life almost or quite without organization, the maxim not only is not necessarily true, but is necessarily untrue. It applies, as it must ever apply, to living things in general, but not to those living things which exemplify the bottom characteristics of the group. *Omne vivum ex vivo* was not written of the type. If it were, *ex nihilo nihil fit* could not be written too.

"According to the material contention," avers Dr. Beale, "everything owes its existence to the properties of the material particles out of which it is constructed." Whereupon he rather scornfully asks, "Who would think of asserting that in the properties of brass and iron or steel we shall find the explanation of the construction of a watch?" Nobody; with this interrogatory Dr. Beale knocks over a man of straw set up with his own hands. What he calls "the material contention" is really that every phenomenon owes its existence to the properties of matter; but this contention his crucial instance does not meet, for denying that a watch owes its existence to "the properties of brass and iron or steel" is not denying that it owes its existence to material properties, acting under special conditions, in special combinations, according to special laws, and emerging into a special organism, with the capability of watch-making.: he answers what is asserted by denying what is not asserted. The fallacy, however, may suggest the clew to a better comprehension of the reality. Why do

not "brass and iron or steel" manifest the phenomena of watch-making? For essentially the same reason that primitive man did not manifest them: because in these metals, as in primitive man in an immensely less degree, the synthesis of forces is too simple and unevolved, it being a law of matter that every state of material forces not only is derived from preceding states, and manifests phenomena peculiar to itself, but that the more complex and evolved the state, the more complex and evolved the phenomena. In this law, speaking broadly, we have a key to the source of life. Oxygen, hydrogen, carbon, and nitrogen, uncombined, present, for example, one state of material forces, which manifests one set of phenomena; water, formed by the combination of oxygen and hydrogen, is another state, less simple, and manifesting less simple phenomena; alcohol, resulting from the union of oxygen, hydrogen, and carbon, is another state, more complex, and manifesting more complex phenomena; carbonate of ammonia, consisting of oxygen, hydrogen, carbon, and nitrogen, is another state, more complex still, and manifesting phenomena of corresponding complexity; and protoplasm, containing the same elements as carbonate of ammonia, but united in higher multiples, and uniting under conditions unknown though not unknowable, is simply another state, more complex than any of the others, and manifesting the phenomena of life, which, it deserves to be noted, are no more peculiar to life than the phenomena of alcohol are peculiar to alcohol, or the phenomena of water peculiar to water. The peculiarity is the peculiarity of every state alike, as could hardly be otherwise, unless a thing could be itself and at the same time something else.

In the lower states of matter this law offers no difficulty; but, as the successive states become more and more removed from the elementary state, exhibiting phenomena more and more removed from the elementary phenomena, it grows, first indistinct, next unperceived, then unimagined, till at length, culminating in life and mind, it eludes definite conception in the bewildering complexity of the phenomena, and its consummate product, puffed up by the height to which it has raised him, turns round and disowns it altogether, perversely kicking over the ladder by which he ascended, and proudly asserting his right to pose upon nothing. Yet the law is none the less operative at every stage, from nebula to consciousness, and in itself is as comprehensible in the last stage as in the first. That one synthesis of forces should issue in life is at bottom not more wonderful than that another synthesis should issue in water. The two manifestations are equally comprehensible up to a certain point, beyond which they are equally incomprehensible, a mystic chasm, soundless yet crossed by a step, bounding equally every atom of the wide universe; only, in so simple a thing as water, the step whereby we cross this ever-recurring interval need not be often repeated, and the approach is comparatively open, whereas, in life, to say nothing of mind, the step is to be taken

such countless times, in such countless directions, within such countless chambers, passages, recesses, that no wonder the broadest and loftiest intellect of our time, or of any time, stood baffled at the threshold of the labyrinth until he had fashioned the clew of Evolution to guide him through its windings; but the step, though infinitely multiplied, is one and the same, spanning ever the same fathomless chasm, and the faculties which enable us to take it once render us competent to repeat it indefinitely. We thread the maze by a developed use of the powers by which we enter it, treading always over, but never into, the meshes of infinity. The real difficulty, as already implied, is that our present knowledge and intellectual training do not match the complexity of the higher phenomena, which, notwithstanding their astounding complexity, differ from the lower only as a problem in the calculus differs from a sum in addition and subtraction. Fundamentally, there is no difference in the phenomena, and no break: all are interconnected by one unbroken chain of causation. As the watch-maker is developed from primitive man, so is life developed from primitive matter, and the gap between these is no more impassable and no less than the gap between those, or, for that matter, than between the simplest compound and its elements, or between the atoms of the elements themselves. The interval in every case is essentially identical. If it makes life mysterious, it makes mysterious every other thread in the texture of things. The mystery is the same throughout; and so is the only explanation with which the wit of man can embroider the somber secret.

Dr. Beale has nothing more to say with which we need concern ourselves. He is, as I have said, a physician of eminence, and, I may add, a microscopic observer of approved accuracy; but as a philosophical critic he is not a success. I have treated him with courtesy, out of respect for the proprieties of serious discussion rather than for his deserts. The tone of his paper is not candid or respectful; its spirit is derisive; and the body of it is composed chiefly of a tirade, not conspicuous for judgment or comprehension, against the decay of modern thought and the dogmatism of modern scientists, among whom he generously singles out Professor Huxley as a scape-goat, and, laying both hands on his laureled head, confesses over him, with much unction but no fair words, all the iniquities of the children of light, and halloos him, crowned with the shining burden, into a land not inhabited by members of the Victoria Institute. But all this I pass by. It is tempting, I confess, but space or the lack of it, if nothing better, delivers me from the temptation. On the title-page of Dr. Beale's pamphlet is inscribed: "The New Materialism; Dictatorial Scientific Utterances, and the Decline of Thought." Of this inscription the first part might stand, fitly enough, for the title proper, and the last part for the characteristics of the paper, were it not that its "dictatorial utterances" happen not to be "scientific," and that its "thought"

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In the lower states of matter this law offers no difficulty; but, as the successive states become more and more removed from the elementary state, exhibiting phenomena more and more removed from the elementary phenomena, it grows, first indistinct, next unperceived, then unimagined, till at length, culminating in life and mind, it eludes definite conception in the bewildering complexity of the phenomena, and its consummate product, puffed up by the height to which it has raised him, turns round and disowns it altogether, perversely kicking over the ladder by which he ascended, and proudly asserting his right to pose upon nothing. Yet the law is none the less operative at every stage, from nebula to consciousness, and in itself is as comprehensible in the last stage as in the first. That one synthesis of forces should issue in life is at bottom not more wonderful than that another synthesis should issue in water. The two manifestations are equally comprehensible up to a certain point, beyond which they are equally incomprehensible, a mystic chasm, soundless yet crossed by a step, bounding equally every atom of the wide universe; only, in so simple a thing as water, the step whereby we cross this ever-recurring interval need not be often repeated, and the approach is comparatively open, whereas, in life, to say nothing of mind, the step is to be taken

such countless times, in such countless directions, within such countless chambers, passages, recesses, that no wonder the broadest and loftiest intellect of our time, or of any time, stood baffled at the threshold of the labyrinth until he had fashioned the clew of Evolution to guide him through its windings; but the step, though infinitely multiplied, is one and the same, spanning ever the same fathomless chasm, and the faculties which enable us to take it once render us competent to repeat it indefinitely. We thread the maze by a developed use of the powers by which we enter it, treading always over, but never into, the meshes of infinity. The real difficulty, as already implied, is that our present knowledge and intellectual training do not match the complexity of the higher phenomena, which, notwithstanding their astounding complexity, differ from the lower only as a problem in the calculus differs from a sum in addition and subtraction. Fundamentally, there is no difference in the phenomena, and no break: all are interconnected by one unbroken chain of causation. As the watch-maker is developed from primitive man, so is life developed from primitive matter, and the gap between these is no more impassable and no less than the gap between those, or, for that matter, than between the simplest compound and its elements, or between the atoms of the elements themselves. The interval in every case is essentially identical. If it makes life mysterious, it makes mysterious every other thread in the texture of things. The mystery is the same throughout; and so is the only explanation with which the wit of man can embroider the somber secret.

Dr. Beale has nothing more to say with which we need concern ourselves. He is, as I have said, a physician of eminence, and, I may add, a microscopic observer of approved accuracy; but as a philosophical critic he is not a success. I have treated him with courtesy, out of respect for the proprieties of serious discussion rather than for his deserts. The tone of his paper is not candid or respectful; its spirit is derisive; and the body of it is composed chiefly of a tirade, not conspicuous for judgment or comprehension, against the decay of modern thought and the dogmatism of modern scientists, among whom he generously singles out Professor Huxley as a scape-goat, and, laying both hands on his laureled head, confesses over him, with much unction but no fair words, all the iniquities of the children of light, and halloos him, crowned with the shining burden, into a land not inhabited by members of the Victoria Institute. But all this I pass by. It is tempting, I confess, but space or the lack of it, if nothing better, delivers me from the temptation. On the title-page of Dr. Beale's pamphlet is inscribed: "The New Materialism; Dictatorial Scientific Utterances, and the Decline of Thought." Of this inscription the first part might stand, fitly enough, for the title proper, and the last part for the characteristics of the paper, were it not that its "dictatorial utterances" happen not to be "scientific," and that its "thought"

exhibits not so much "decline" as destitution. However, I am not inclined to deal severely with the distinguished professor, and accordingly content myself with flinging back the title-page into his teeth.

HOMŒOPATHY AS A SCIENCE.

By EDWARD BAYARD, M. D.

"Philosophy and science are so related as to constitute a unity."—"The Relations of Mind and Brain," CALDERWOOD.

MANY of the most important discoveries of the psychologists were rejected by the physiologists, because they could not be proved by their law—and conversely with the psychologists. These contending forces have been brought into lasting alliance by Professor Calderwood. It is believed that as close a relation can be established between Nature's laws and those of homœopathy.

Vaccination, as the sole and sure preventive of small-pox, is one of the great, dominant, fixed facts of the old school. Here is the open and avowed application of the law of cure by similars, *similia similibus curantur*. If it be a law of cure in one case, by what logical process can it be demonstrated to fail in all others? Those most conversant with Nature's laws assert, and truly, that she makes no exceptions: the law of gravity; that water seeks its own level; that the pressure of water is equal in all directions; that sound ascends; that heat expands. It was this universality of the law of Nature which enabled the great naturalist, Cuvier, to construct a whole skeleton from two or three bones. So, with equal certainty, if necessary, could the skeleton of the homœopathic law be evolved from this single bone of its structure—vaccination. Starting from different stand-points, the old and new schools have progressed in the same direction, to diminished doses, both in size and repetition. This is concededly due in the old school to the influence of homœopathy, in the new it is the growth of its own experience.

Messrs. Bell and Laird, in their admirable monograph on diarrhœa, say: "There is indeed a somewhat prevalent opinion that the strength of the dose makes up for want of due care or knowledge in selection. This may be stated in mathematical terms, as follows: If the thirtieth potency of arsenic is equal to a complete knowledge of the drug, one fifth of a grain of arsenious acid is equal to complete ignorance of it. Stated in this, its true form, we grant it."

Homœopathy, as a science, is the law of the vital force; the body is but the mechanism upon which it operates. The dissecting-knife has laid bare to the astonished gaze of the student a perfect organism, while the operating-table presents the companion picture of an organ-

ism in total ruins dominated by the vital principle. What, then, is disease—typhoid, pneumonia, scarlet fever? No; disease is the impairment of the equalization of the vital force, and it finds expression where the organism is weakest.

What is cure—to take physic for typhoid or scarlet fever? No; to cure is to locate the center of the disturbance, the diseased nerve-cell, and restore the equilibrium.

How do you do this? In spite of its many ramifying influences, the nerve-cell preserves, to the close and exact student, its individuality, often veiled under the apparently familiar features of others, but still recognizable by the differentiating mind. It is this similar of state and remedy which the homœopathic physician, who knows and applies the law, seeks in the patient and in the materia medica; when found, the means of restoring the equalization of the vital current is found with it.

As there is but one nerve-center of a disease, so is there but one remedy.

The system has always a tendency to resist, by reaction, the morbific cause which disturbs it. The similar stimulates reaction. When you put your hot hand into hot water, and take it out and wipe it dry, by the law of reaction it becomes cool. So, if to the frost-bitten ear or hand you apply snow or ice, by the law of reaction the frozen part burns under its stimulus. The power of resistance, which is reaction, is the strength of the constitution, or is the constitution itself. It is this law of reaction under which homœopathy works, by its similars stimulating the additional resistance necessary to aid in nature's cure.

If you go out into excessive cold, and the power of resistance is equal to the demand, you turn red; if not, and this power is overwhelmed, you turn white. And the same difference is markedly observable among those who take sea-baths. By the law of reaction they vary in color from that of a boiled lobster to the livid hue of death, graduated and shaded off by the loss of the power of resistance. All cures are sought by homœopathy under this law, and depend for their success upon this power of resistance, and it is of vital importance that this power be not diminished, for without it there can be no cure. Outside of medicine this law of reaction in the system is recognized as an accepted fact. It is the law of cure, and the study of this law is a science, and that science is homœopathy.

The reason why scarlet fever, measles, chicken-pox, and small-pox do not, as a general rule, recur in the system is that, at the first attack, the system has reacted so strongly against these diseases as to be proof against a second attack. The reaction has so strengthened the system to resist the particular form of morbific influence that it will not readily yield to it again.

"Homœopathy is another form of quackery," says a writer in the June number of "The Popular Science Monthly." It might be ob-

jected to his method of treating the subject that no *a priori* argument can suffice in the forum of reason where practical tests and material results may be had, by any one so in love with the truth as to seek it, by going frankly to eminent homœopathic physicians and obtaining permission to study their treatment in a given number of cases, and, with a mind disabused of prejudice, carefully examining and noting each case and giving the results of such observations. There would then, at least, be some facts which would give currency to the alloy of mere argument.

There is certainly no more reason, viewed from a logical standpoint, why the inducing of symptoms or sufferings different from those produced by disease should prove more efficacious in cure than a remedy which produces similar symptoms. It may be so; but the mere assertion does not establish it. The question is one of fact; it does not belong to the domain of reason. However absurd the theory of one school may appear to a disciple of the other, the question remains, Which system cures?

It is asserted that infinitesimal doses, a decillionth part of a grain, can not cure. This statement is based upon the assumption that a dozen, or twenty, or more grains, given by the allopathic school in single or quickly repeated doses, are necessary to effect a cure, and that so given they do cure, which is to assert that allopathy is the only true standard and measure of cure, and that any material deviation therefrom is error. But, if the premise be denied, the conclusion fails.

Of the uncertainty of cure by allopathic remedies, let one of the most eminent of that school speak—that man of attainments and ability, Sir John Forbes. In his work entitled "Nature and Art in Disease," a solemn legacy to his younger brethren, he says:

"And yet what is the character of the results obtained under this system" (homœopathic) "of imaginary medication in the cure of diseases? When fairly weighed do not these results exhibit, if not quite as large a proportion of cures as ordinary medicine, still so large a proportion as to demonstrate at once the feebleness of what we regard as the best form of art and the immense strength of Nature in the same office. . . .

"The favorable results obtained by the homœopaths—or, to speak more accurately, the wonderful powers possessed by the natural restorative agencies of the living body—demonstrated under their imaginary treatment, have led to several other practical results of value to the practitioners of ordinary medicine. Besides leading their minds to the most important of all medical studies, that of the natural history of diseases, it has tended directly to improve their practice by augmenting their confidence in Nature's powers, and proportionately diminishing their belief in the universal necessity of art, thus checking that unnecessary interference with the natural processes by the employment of heroic means, always so prevalent and so injurious. It

has been the means of lessening in a considerable degree the monstrous poly-pharmacy which has always been the disgrace of our art, by at once diminishing the frequency of administration of drugs and lessening their dose. . . .

"In a word, almost every drug in our overflowing materia medica, whether inert or active, has been on one ground or another copiously prescribed in every variety of disease under the supposed sanction of this pseudo-specific on empirical indication. Nor let it be supposed that this empirical practice is one of the past day only. It is at this very time in as great vogue as ever, although its employment may be often veiled under the technicalities of newer science.

"Nor is it confined to the ignorant or inexperienced among us, but adopted and followed by men of the greatest abilities and greatest eminence in the profession. . . .

"As in religion and politics, and in those departments of knowledge which are not of a positive or demonstrable kind, early and long-continued education, comprising not merely direct instruction, properly so called, but the influence of habitual example, deference to seniority and superiority, unconscious imitation, etc., induce conventional belief of the strongest kind—strong as demonstrated truth itself—and create a sort of wizard circle of power, beyond which the mind of the disciple, however bold, scarcely ever dares to wander. So in medicine, the great majority of practitioners retain the same doctrines and pursue the same practice which they learned in the schools, or, if changing both doctrine and practice, as time and fashion dictate, hold fast, at least, the great fundamental doctrine impressed upon the very core of their professional hearts—viz., that the interference of Art is essential in all cases, and therefore never to be foregone. It need not, therefore, surprise us that it is only a very small minority of medical practitioners who, in ordinary circumstances, can see in disease the true workings of Nature through the artificial veil which conventionalism and professional superstition have thrown over them. . . .

"The conviction of the great autocracy of Nature, in the cure of diseases derived from this source, is much more widely spread among the senior members of the profession than is at all believed by the great body of practitioners. . . . The number of cases that recover and would have died had Art not interfered is extremely small."

These trenchant words from Sir John Forbes carry great weight as a commanding critic in his own profession. Had his strictures upon his brethren and their practices come from an alien pen, they would undoubtedly have been attributed by the allopathic school to malevolence and ignorance; and, doubtless, Sir John Forbes will not escape the same fate, because, if his statements are true, those of whom they are spoken are incapable of perceiving or admitting their truth.

But, conceding the allopathic to be a correct or a possible system of cure, it by no means follows that because it requires large doses to

create different symptoms or sufferings, it likewise requires doses of equal quantity to create *similar* symptoms to those to which the system is already so greatly predisposed.

The atomic dose will, however, bear a much closer and more severe test than has been applied to it. It is an approved and well-known fact that a person of iron will will battle long and successfully with a disease which baffles the aid of the most skillful physician, and it is said that his will sustains him. By that is not meant that he leans upon his will as upon a staff, nor that the immaterial, the will, comes in actual contact with the material, the disease; but that the will, acting through the brain, rouses up in the system material resistance to the disease, and effects a cure or prolongs the fight. How much brain would one have to eat in order to obtain a decillionth part of a grain of the will-power which operated in the system in effecting a cure or battling with the disease? The will operating through the brain moves one joint of the little finger, then two, then three, and so on until it moves by one operation of the will the whole fourteen joints of the five fingers, which act in unison at one motion. Yet it is clear that each additional joint moved resulted from the impression made upon a larger area of the nerve-centers in the brain. Assuming for the sake of argument that the correct method of cure is to arouse in the system a direct reaction against disease, and that this can only be accomplished through the brain, it follows that the remedy, which in form is best adapted to act upon the brain, is the best so far as mere form is concerned; and if the immaterial, the will, can produce such positive physical results, the quantity of the medicine operating upon the brain is not required by any law of physics (or physiology) to be many times greater than the nerve-cell, which is the body to be operated upon; especially must this be true when the object sought is not to overwhelm the nerve-center, but simply to stimulate it to increased action.

Professor Calderwood, in his "Relations of Mind and Brain," says of the nerve-cells in the brain: "These are so numerous as to baffle calculation. From the number seen within a small section under the microscope, it is reckoned that there must be many thousands of them in the human brain." Of the nerve-fibers he says: "In the brain itself they are sometimes as minute as a twelve-thousandth part of an inch," and that the smallest of the nerve-fibers in the eye are from $\frac{1}{50000}$ to $\frac{1}{10000}$ part of an inch in diameter. As an adaptation of means to end, a decillionth part of a grain, broken up into many still more minute particles, does not appear to be so much out of proportion to the nerve-cell or to the ducts, the nerve-fibers, as the two, four, six, or more grains given by the allopaths.

The stench contained in a few drops distilled by a skunk attains a potential existence in the air for not less than five hundred feet in every direction. Taking one thousand feet cubed as a minimum, we

have one billion cubic feet of air saturated with the smell. Not only is this space filled once, but it is kept filled for an hour, radiating out indefinitely into space; from which it is clear, according to our critic, that a passer-by, an hour afterward, deceives himself by a supposititious shock to the sense of smell caused by the decillionth part of the drop of skunk-odor. But the involuntary clapping of the hand to the nose affords conclusive proof that both the sensor and motor nerves have been sensibly affected.

That in a chemical laboratory there is no appliance so sensitive as a diseased nerve, does not argue the inefficacy of the atomic dose, but proves the want of adaptation of the chemical apparatus to deal with the subject.

Hahnemann's method of trituration is urged as an argument against his principles, without showing that it has anything to do with the principles, or that it fails to accomplish the object sought. The work is now done with great exactness by machinery.

It is said that since the discovery of the *Sarcoptis hominis*, or itch-insect, the dogma about psora being such a powerful factor in the causation of diseases has fallen to the ground; that is to say, that those who supported this theory have been, by this discovery, forced to abandon it. Why? Evidently because the theory is inconsistent with the itch-insect. But who proves it? Is the disease the cause of the insect, or the insect the cause of the disease? Do maggots breed carrion, or carrion maggots? Was Hamlet trying to shift the responsibility of Polonius's death from himself to the worms?

"Now, Hamlet, where's Polonius?"

"At supper."

"At supper! Where?"

"Not where he eats, but where he is eaten. A certain convocation of politic worms are e'en at him."

That is, the worms killed Polonius.

But it is clear that Hamlet was not so mad as that, for he said, "For if the sun breed maggots in a dead dog, being a god-kissing carrion—"

So will psora breed the *Sarcoptis hominis*, but so will not the insect breed the itch. Being but the effect, it can not produce the cause. It is not its own *causa causans*.

Homœopathy has suffered, and is likely to suffer, more from its friends than from its enemies.

Persons who adopt it as an easy means of gaining a livelihood are apt to fail, and fall back upon the allopathic school, with its nosology and procrustean prescriptions. Few are those in any calling who have either the frankness to confess or ability to perceive the cause of failure to be from within. The convenience of a name for every disease is apparent. It relieves from further investigation. How little Dr. Shepherd knows of the laws of homœopathy may be demonstrated

by a single sentence. He says: "Hahnemann paid no attention to pathology or cause of disease, but only sought for symptoms. For instance, in a case of dropsy, the cause, whether it be from the heart, the kidneys, or the liver, is not inquired into, but *the symptom dropsy is treated.*"

It is clear that the writer here uses the term "cause of disease" as synonymous with the part affected, which is to confound cause and effect, and he substitutes his own nosology "dropsy" for the group of symptoms which indicate, not dropsy, but the remedy to be selected. The fact that the heart or kidneys or the liver is affected does not indicate or prove that the one affected is the cause of disease. It proves that the disease has affected that part, and it follows by an inexorable law that the part affected can only be cured by removing the cause. It is this inversion of cause and effect, of disease and its point of attack or expression, this ignorance of Nature's laws, which induces the allopath to attempt to cut out the core of what he calls cancer; thus trimming the branches of this mighty disease, to strengthen it at the roots, seated deep down in the system. It is like cutting down a locust, and producing a forest from the roots. How can a school, which has been a thousand years dissecting dead bodies to discover the vital principle, hope to free itself from its dogmas? As well might it be expected to discover the electric fluid by dissecting a yard of telegraph-wire. Professor Calderwood, who is not a homœopathist, demonstrates, as a scientist, from the discoveries of the foremost physiologists and psychologists, that, by tracing up all of the group of symptoms along the nerve-fibers, we will reach a common nerve-center in the brain, differing in area and location with differing groups of symptoms. This nerve-center is operated upon by certain sensor nerves. The whole object of the homœopathic physician, who is true to the law, is to trace these symptoms to a common nerve-center, and then to select a remedy which, acting upon that nerve-center, will, on the line by which Nature cures, stimulate a reaction, and thus restore the equilibrium, which is perfect health.

The law of Nature's cure is, by rousing up reaction against disease, to restore the disturbed forces to their exact counterpoise, where action and reaction are equal. The allopathic method of creating a new disease to cure the old one is a violation of this law, and at the very outset the regular school must begin by an apology or an excuse, either that Nature has denied to men the means of executing her laws, or that man is ignorant of the means she has placed at his disposal.

As an abstract question, preference must be given to that method of cure which creates the least disturbance in the system, and, as a consequence, leaves it less liable to relapse or a second attack; which does not by antagonizing the vital forces reduce or destroy its economies; which does not work by rule of three; as the remedy is to the

disease, so is the constitution to the condition of the patient when the disease shall have left it. Convalescence in homœopathy commences when the correct remedy begins to act. In allopathy, when the remedy and disease have left the patient prostrate, then Nature takes the matter in hand. It is a common error with the ignorant traducers of homœopathy that the higher the potencies or its remedies the weaker they become, as one weakens wine by adding water. It is sufficient answer to quote the following high authority, who discloses the true purpose and effect:

"If it be conceded that the vital principle is identical with electricity, the action of dynamized medicaments becomes easy of comprehension; for in these preparations we have material substances subdivided to a degree that enables them to penetrate the most delicate tissues of the body."—(Dr. Currie's preface to Jahr's "Homœopathic Manual.")

The writer's assertion, that "homœopathy, being a system utterly void of any scientific foundation, is now dying a natural death," receives, to say the least, doubtful support from the animated debate which has been progressing so vigorously in the New York County Medical Society of the regular school in reference to consultation with homœopaths, where the exclusionists accused the more liberal brothers of having an itching palm for the fat fees which now find their way, without chance of tax, to the pockets of the homœopathic physicians, while the argument by the liberal members is that as now homœopathy has progressed and its disciples have a thorough medical education, there is no longer any reason why they should be treated as quacks and impostors. So far as noted, the alleged moribund condition of homœopathy had escaped their observation.

What shall be said of the pretensions to be enrolled with the sciences of that school which has progressed from one stage of universal disease or cause and remedy to another—typhoid, malaria, miasm germ, bleeding, calomel, morphine, quinine—by discarding nearly all that its pioneers held most dear; which, before it can build, must tear down; which retreats from the necessary labor of that scientific investigation which by great diligence and skill eliminates every remedy but one as useless or hurtful, to take refuge in a nauseous mixture of several powerful drugs, administered upon the hit or miss blunderbuss principle—those drugs which are neither allopathic nor homœopathic to the disease, doing more potent injury than the one (which by hap-hazard has some relation) can do good, as Sir John Forbes says, "the monstrous poly-pharmacy which has always been the disgrace of our" (the allopathic) "art"?

It may well be doubted whether homœopathy will ever have enrolled under its banners the same number of practitioners as the regular school. The nearer we approach to an exact science, the fewer are its votaries. The conditions admit fewer. In it there are no formulated

diseases nor formulas for prescriptions. It is differentiation as opposed to classification or generalization. The effect, expression, or impression of disease, is not mistaken for disease as a cause. Subject one hundred persons of both sexes and various ages to a cold rain and then to a burning sun, and you will have as many different states as persons. The disturbance of the vital force has found expression in a hundred different forms. It is in the province of the homœopathic physician to locate the center of disturbance, and then to select as the remedy, by a process of elision from the many similars in the materia medica, the one which most nearly coincides with the expression of the disease or symptoms. When this process sometimes involves the most experienced and skillful physician in a profound study of one, two, and three hours and of re-examination as the expression changes, requiring due weight to be given to each symptom, both relatively and positively, and then to assume the grave responsibility of administering a single remedy and awaiting the result, it will be readily seen that those who are faithful to the law, and able to administer it, will be few.

By operation of the will a strong man liberates from a nerve-center of his brain nerve-energy which, acting along the motor nerves, liberates in its turn sufficient muscular energy to fell an ox. Here the immaterial, the will, has produced a most powerful material result. Suppose for a moment that the nerve-energy had been misdirected, as in case of shock from mental causes, and had all been expended within the man, who would answer for the result?

In the heroic struggle which Nature, unaided, makes against disease, the assistance from Art necessary to speed the cure may in a great majority of cases be set down in decimals, as follows:

Nature.....	·999
Art.....	·001

and it will be pretty safe to say that, whenever the proportion is against Nature, there will be no cure.

It is the $\frac{1}{1000}$ which Art is called upon to throw into the scales and make them equal. If she adds more, she destroys the balance.

The atomic dose is adjusted to restore the balance. It is the infinitesimal fraction Nature needs to make the unit health.

If you accept the germ-theory of disease, and attribute to the atomic germs, floating impalpable in the air, or carried long distances through the mails on highly calendered writing-paper, from mere contact with the hands of diseased persons, the power of communicating disease and completely overwhelming the vital power, causing death, you can not logically deny to the atomic dose all aid to the vital power in resisting and defeating the attack of the atomic germ of disease simply because the dose is atomic. Nature, unaided, in a vast number of cases, successfully resists those diseases which are attrib-

utable, by those who maintain the germ-theory in disease, to atomic germs. The number of disease-germs does not matter, as is evidenced by the communication of disease by letter where the number must necessarily be limited. The atomic dose is but a stimulus to Nature. Nature cures, aided or unaided. The atomic dose but excites in a greater degree those powers of reaction and resistance of Nature already set in motion by disease—which is a disturbing cause. Nature always seeks to restore the equilibrium of her forces.

THE LIVER-FLUKE OF SHEEP.

By BYRON D. HALSTED, Sc. D.

THE object of this paper is to briefly summarize the present knowledge of the liver-fluke, causing the much-dreaded and fatal "rot" in sheep. Professor A. P. Thomas, of Balliol College, Oxford, has completed his long and extended researches on this parasite, which have been carried on under the direction of the Royal Agricultural Society of England. Professor Thomas's concluding report appeared in the last issue of the "Royal Agricultural Journal," from which the leading facts here given are drawn and the engravings borrowed.

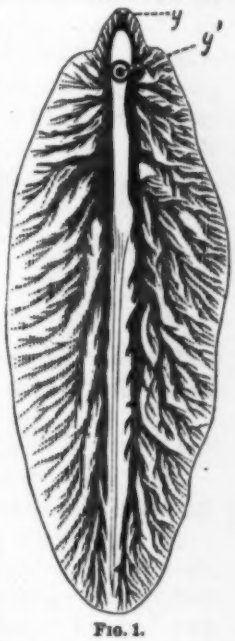

Fig. 1.

The liver-fluke, shown twice the natural size in Fig. 1, is a sucking-worm related to the common leech, and known to zoölogists as *Fasciola hepatica*. It has the shape of a privet-leaf, is pale brown or flesh-colored, and from an inch to an inch and a third in length. There is a short projection at one end, and at its tip, *y*, is a sucking-mouth by which the fluke can attach itself to the surface of the bile-ducts of the sheep. A second sucker, *y'*, is situated at the place where the head joins the body. These flukes are found in abundance in the livers of sheep and other animals infested with the "rot," and produce vast numbers of eggs. Each of these eggs under proper conditions gives rise to an animal "which is never like its parent, never does become like it, and never lives where its parent lives." It will be seen that in the liver-fluke we have an example of what is known among naturalists as an alternation of generations.

The eggs, one of which is shown in Fig. 2 very highly magnified, are about $\frac{1}{100}$ of an inch in length, but may be made visible to the

naked eye by shaking some of the dark-brown contents of an infested bile-duct in a glass of water and holding the vessel up to the light. The line marking off the lid of the egg may be seen near the right end,

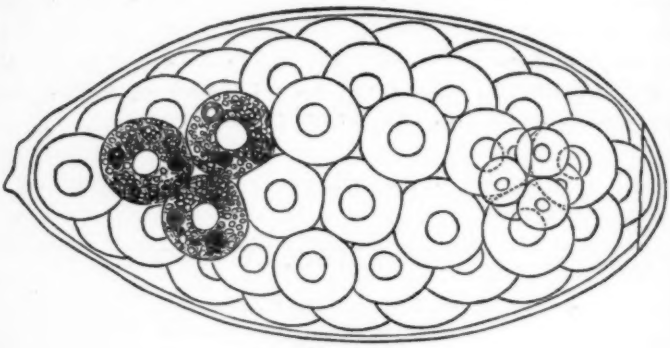

FIG. 2.

and a little to the left is the embryo in its early state of development. It is surrounded by large granular masses, which serve as food. Only three of these masses, at the left hand, have been fully drawn. In one case Professor Thomas found seven million eggs in the gall-bladder of

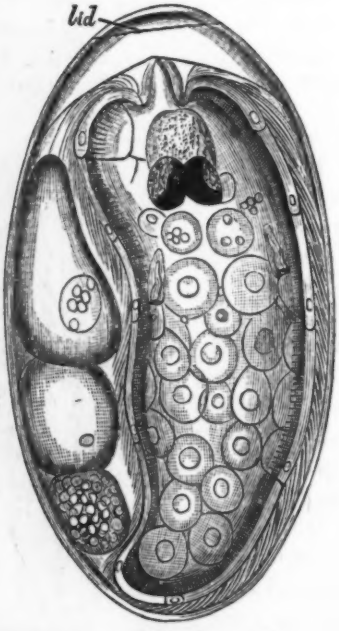

FIG. 3.

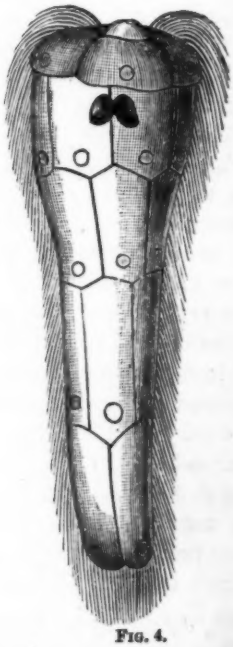

FIG. 4.

a single sheep, while the liver contained about two hundred flukes. The number of eggs produced by a single fluke may be safely estimated as half a million. No further changes take place in the egg

while it remains within the infested sheep. The eggs are, however, naturally washed away by the bile into the intestines, and finally pass from the sheep and are distributed with the droppings. If the eggs fall upon wet land, further changes take place during warm weather, and an embryo is formed. Fig. 3 shows a fluke-egg with the embryo fully formed within the shell. The body of the embryo is covered with cilia, by the motion of which the young trematode is propelled through the water. Both of the engravings (Figs. 3 and 4) are highly magnified. In swimming, the broader end is directed forward, and in its center is a projection, used as a boring-tool. The embryo has very simple eye-spots, which render it sensitive to light, and aid it in finding its future home. When the swimming embryo comes in contact with any object, it feels about, and, if not suited to its wants, starts off again. If the object met with is the snail (*Limnæus truncatulus*), shown in Fig. 5, it at once bores into it. In boring through the shell of the snail, the peg-like projection is extended, and the embryo spins around rapidly by means of the cilia. The natural place for the further growth of the embryo is in or near the lung of the snail, and when once lodged there its eye-spots and cilia disappear, and the body becomes oval in shape. Figure 6 shows the embryo while the changes are taking place. When the changes are completed the animal is called a *sporocyst*, meaning a sac of germs. The sporocysts live at the expense of the snail, and will, in July weather, reach their full growth, $\frac{1}{10}$ of an inch, in a fortnight. Fig. 7 shows a full-

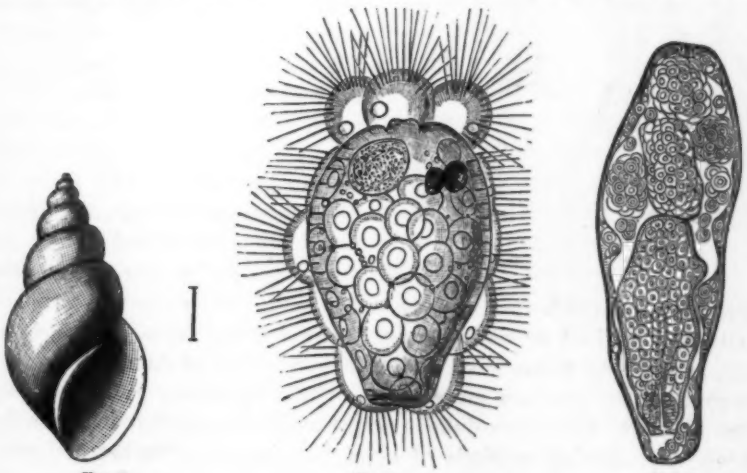

Fig. 5. Fig. 6. Fig. 7.

grown sporocyst, or first generation of the liver-fluke. It contains a number of germs, the lower one of which is ready to hatch out. This is the second generation, and is named *redia*, after Redi, the celebrated anatomist. The young redia, when ready, breaks through the wall of the parent, and the wound thus formed closes up, and the re-

maining germ rediæ continue to grow. The sporocysts also multiply by simple division, thus causing still greater increase in the number of parasites in the snail. A young redia is shown in Fig. 8, with the contents forming into the third generation of the liver-fluke. A full-grown redia is seen in Fig. 9, much magnified. Some of the germs of the *cercaria*, as they are termed, may be seen within the redia. Each of these germs develops into a tadpole-like animal, with a slender tail. A redia may produce a score of the cercariæ, which escape from the parent through a special opening and then wriggle their way out of the snail. The free-swimming life of the "tadpole" does not last long, and after coming to rest it draws its body into a small sphere, and exudes a gummy substance, which protects it from injury. These encysted cercariæ are destined to find entrance to the liver of the sheep and then develop into the full-grown fluke. Fig. 10 shows a free cercaria as seen swimming in water, and in Fig. 11 is seen a portion of grass upon which three cysts are fastened. The cysts remain attached to the herbage of the pasture, and are swallowed by the sheep in feeding upon the ground. If the cysts are not picked up by the sheep within a few weeks, the young flukes which they contain will perish. It has been determined that two hundred or more cercariæ may descend from a single fluke-egg, and, if the rediæ give rise to a generation of daughter-rediæ, a single egg may produce more than a thousand cercariæ. "Not only does the race of the liver-fluke multiply and increase abundantly in the sheep by producing myriads of eggs, but there is a further and great increase of the forms within the snail. If only the greatest degree of ordinary increase were reached, a single fluke might give rise to more than a hundred million descendants in the next generation of liver-flukes proper inhabiting the sheep. But, fortunately for farmers, the chances are enormously against any such disastrous increase."

FIG. 8.

FIG. 9.

Professor Thomas has determined that at least six weeks elapse,

from the time the encysted cercaria is swallowed by the sheep, before the fluke is fully grown and begins to lay eggs. The flukes do not always pass from the sheep in summer-time, as was once thought by leading veterinarians. There is no time of year when sheep-livers

FIG. 10.

FIG. 11.

containing flukes can not be obtained. Cases are known where the flukes have been known to live for more than a year.

The summary of the life-history of the liver-fluke is given as follows: "The adult fluke in the liver of the sheep produces enormous numbers of eggs, which are distributed with the droppings of the sheep. If these eggs have moisture and a suitable degree of warmth, they continue to live, and in each is formed an *embryo*. The embryo leaves the egg and swims in search of the particular snail (*Limnæus truncatulus*) within which its future life and growth take place. The embryo bores into the snail, and then grows into the form which is called a *sporocyst*. The sporocyst gives rise to the second generation. This generation is known as the *redia*. The rediæ in turn produce the third generation, which has the form of a tadpole, and is called *cercaria*. The cercariæ quit the snail and inclose themselves in envelopes or cysts, which are attached to the grass. When the grass to which the cysts adhere is eaten by sheep or other suitable hosts, the young liver-fluke comes out of the cyst and takes up its abode in the liver of its host, and the fatal circle is thus completed."

The fluke-disease alternates between a kind of snail and the sheep. One sheep can not contract the "rot" directly from another member of the flock, and one snail can not take it from its neighbor. The sheep drop the eggs, and hatching, the embryos, find the snails, and

the snails after nursing the young flukes through three generations distribute the tadpole cercariæ, which convey the infection back to the sheep, and it there inhabits the liver and causes the disease.

THE PREVENTION OF THE ROT.—Now that the life-history of the fluke is known, it is not difficult to comprehend the conditions necessary for its existence. There must be: (1) Fluke-eggs on the ground; (2) wet ground or water during warm weather — (3) the snail *Limnæus truncatulus* (?); and (4) sheep allowed to feed upon the infested ground.

Under the first condition it may be said that wherever fluked sheep are kept we shall have fluke-eggs. In some districts flukes are always to be found, and where the conditions are the most favorable a sudden outbreak may be expected. The disease sometimes appears in quarters where it was previously unknown, and may have been introduced in manure containing fluke-eggs, or adhering to the feet of cattle, dogs, or men. The eggs and young flukes (embryos) may be conveyed by running streams, floods, etc. Other animals than sheep are infested with the parasite, and rabbits and hares may be the means of introducing the plague. The production of the fluke-eggs may be prevented by killing the sheep so soon as they are found suffering from the "rot." If there is a suspicion that a flock is attacked, one of the members exhibiting the strongest signs may be killed and its liver examined. If rotted sheep are kept, they should be on dry ground, where the fluke-eggs can not fall on wet land, or be swept into brooks by the descending rains. The manure of infested sheep should not be placed on wet land, and the livers of rotted sheep ought to be destroyed or deeply buried.

The remedy for the second condition is a simple one, but not always easy of application. Wet land should be thoroughly drained, and, besides preventing the rot, it will greatly improve the pasturage. When draining can not be done, lime or salt may be scattered over the surface. These substances will destroy the embryos, the more developed encysted form of the fluke, and the snails which serve as hosts. The salt or lime should be applied in early summer, when the young flukes are present in the greatest numbers.

There seems to be only one snail in England which is host to the young flukes, and the accounts of Professor Thomas in exposing other species of *Limnæus* to the embryos of the fluke are most interesting. The *Limnæus truncatulus* (Fig. 5) is said not to exist in the United States, though several other kinds of snails belonging to the same large genus are found here. It is probable that with us some other species than *Limnæus truncatulus* serves as the host of the intermediate forms of our liver-flukes. Draining the wet land will reduce the number of snails; and dressings of lime or salt, as above mentioned, also destroy them. The lime should be scattered especially on or near marshy places and along ditches. If a pasture has been flooded,

it is well to use the lime to destroy snails which may have been brought down from infested areas.

If there is suspicion that a lowland is likely to give the "rot" to sheep, the best plan is to not allow them to feed upon it. In seasons of excessive moisture it may be impossible to keep the flocks on dry pastures. Salt, as a preventive, may be used in a second way. It acts injuriously upon the germs when fed to the sheep, and it also improves the general health of the animal. In addition to the salt, use dry feed as much as possible. The sheep should not be allowed to graze too closely, for the snails, as a rule, keep near the ground.

If all farmers would unite in carrying out the above preventive measures given by Professor Thomas, the losses from a fatal disease would be greatly reduced. Rabbits and hares are an obstacle to the total extermination of the "rot" in sheep.

The literature of the liver-rot in sheep is specially interesting in the light of our present knowledge. Jennings, in his work on "The Horse and other Live-Stock" (1866), says: "The malady is unquestionably inflammation of the liver. These fluke-worms undoubtedly aggravate the disease and perpetuate a state of irritability and disorganization, which must necessarily undermine the strength of any animal. . . . The sheep, having a little recovered from the disease, should still continue on the best and driest pasture on the farm, and should always have salt within their reach." Youatt, in his work on sheep, in 1848 —back of which date it is not worth while to go—wrote at length upon the "rot." He located the disease in the liver, and states that it has existed from the earliest period of agricultural history. His description of a diseased sheep was full and quite accurate, but the cause was unknown to him. He says, without qualification, that it is inflammation of the liver. The full-grown fluke is too large an object to escape notice in the examination of an infested liver, and therefore was known to Youatt and the veterinarians of his day, but was considered the consequence instead of the cause of the "rot." They believed that the "rot" was connected in some way with the soil, it being confined to wet seasons and to sheep which fed on marshy lands. "It has reference to the evaporation of water, and to the presence and decomposition of moist vegetable matter." In other words, the gases arising from decomposing organic substances cause the "rot." Randall, in his "Sheep Husbandry," states that this view at that date (1860) was universally received by scientific veterinarians. H. Clok, V. S., in his "Diseases of Sheep" (1869), says the "rot" is analogous to "fluke," and is produced by many causes, among which "grazing on marshy or sour meadows" is a leading one. In speaking of the fluke, he says, "The worms are found spontaneously, like all other worms of the viscera, and the opinion that they are introduced into the body with the food, drink, etc., must be considered erroneous."

With the first symptoms of the liver-fluke in sheep there is a tend-

ency to fatten, and animals intended for the shambles have been purposely rotted in order to increase their fattening properties. A celebrated stock-man in England used to overflow his pastures, and, after the water was run off, turn on his sheep which he was preparing for the market. These animals became infested, accumulated flesh rapidly, and by this manœuvre a gain of some weeks was obtained. The practice is certainly questionable, if not positively vicious.

The writer claims no originality in the present paper, and only acts the part—and that imperfectly—of a middle-man in science.

CYCLONES AND TORNADOES.

By GEORGE CLINTON SMITH.

CYCLONES.

TOWARD the western portion of the United States, along the twenty-fifth parallel of longitude, lies a vast tract of sandy, arid country, known to the earlier geographers as "The Great American Desert." It is true, the limits of this great area have become circumscribed by the onward march of civilization, but the sandy waste is still there, and must ever remain. Still farther westward, the Rocky Mountains rear their lofty, snow-crowned heads in one continuous chain, three thousand miles in length. Rich in mineral wealth, the delight of tourists, and the home of a prosperous people, these mountains have a different and equally valuable office to perform in the exercise of an important influence upon the climate of our continent. Were they to be removed, the entire territory west of the Mississippi River would soon become an arid, lifeless desert.

All storms, of any magnitude, that visit the United States, except the tropical hurricanes which sometimes touch the southern coasts, have a common origin in or near the Rocky Mountains. Here the first barometric depression is felt, preceded by a rising temperature, caused by the warm winds moving northward over the sun-heated sands of Arizona, New Mexico, and Western Texas. These warm, rarefied currents of air are met by cooler currents passing over the snow-clad peaks of the north; a cyclonic storm is formed, usually small at first, which begins its journey eastward, gradually developing in energy and area as it goes. After leaving the mountain-ranges, there is but little precipitation for the first few hundred miles; as it advances, it usually widens from north to south, but the line of travel of the storm-center can be readily predicted by the Signal-Service observers, and its location at any time fixed by the lowest reported reading of the barometer.

During the journey of the storm eastward or southeastward, the

wind in advance of it will be easterly, blowing off an area of high barometer into the low; and the barometer will continue to fall. Toward the north of the storm, the wind will be north; and to the south of it the wind will blow from the south, frequently causing what are known on the Western plains as "sand-storms"; while, if the storm occurs during the winter season, the wind and snow in the northern portion is called a "blizzard." In the rear of the storm the wind will be westerly, shifting to northwest, frequently blowing a gale; the barometer will rise and the temperature will fall, sometimes rapidly, and clearing weather will follow.

Thus it will be observed that the true axis is the "storm-center," and that the storm revolves on this axis as it moves forward in an easterly, northeasterly, or southeasterly direction. This is the true cyclone. It may be only a few hundred miles in diameter, or its influence may be felt from British America to the Gulf of Mexico. It may be accompanied by what are known as local showers or storms; or the rains may be general, and of several days' duration. The greatest precipitation is frequently in advance of the storm-center, and may be either rain or snow, depending upon the season of the year and the temperature. During the spring and summer months the area of low pressure is usually accompanied by precipitation in the form of local showers, or thunder-storms, of more or less severity, in which case the strongest air-currents move with the local storm-cloud, and are known as simply high winds, sometimes approaching the severity of a hurricane, but seldom extending over any considerable area of territory.

The true cyclone usually travels from the Rocky Mountains to the Atlantic coast, in nearly a straight line. Sometimes the distance is traversed in four days and nights, exceeding the speed of a railway express-train; but frequently the progress is slow, and the time required much longer, depending largely upon the atmospheric conditions met with in the vicinity of the Great Lakes.

Frequently, while the wind may be blowing from the southeast or northeast, or between these points, the storm is approaching from an opposite direction, and pushes out its cloudy streamers, or "feelers," hundreds of miles in advance. There is, then, no such thing as a "northeast storm," as far as the interior of this continent is concerned.

TORNADOES.

The origin and movement of continental cyclones being understood, we naturally turn, next, to the investigation of tornadoes. These seem to occur most frequently in the Western States, and are usually confined to the territory between latitude 35° and 45° north, and longitude 10° and 25° west. They are purely local in effect, although their cause may be remote; always depend upon and frequently accompany the meteorological conditions developed during the

progress of the cyclone proper across the country. They may occur near, or in advance of, the cyclonic storm-center; or they may appear near the outer edge of the general disturbance, hundreds of miles away. They usually develop within the area of highest temperature, and are often preceded by a brassy sky, and hot, gusty winds, sometimes followed by a sultry atmosphere and an ominous calm. They occur most frequently near the close of the day, their general direction being from southwest to northeast. They vary much in size and force, but all have the same general characteristics in regard to appearance and action; being a funnel-shaped cloud, heavily charged with electricity, that goes bounding and whirling along in close proximity to the earth's surface, dealing death and destruction wherever it touches. The generally accepted belief is, that tornado-clouds are formed suddenly, by the meeting of warm and cold currents of air; or, by the union of a positive with a negative cloud, a partial vacuum being formed, constitutes the axis around which the cloud begins to whirl, gathering strength and increased velocity as it goes.

As the tornado now sweeps onward in its course, it rises and falls with a series of bounds, and, with a swaying motion, describes a zigzag course, now forming a chain of loops, and again shooting off on an obtuse angle, varying in the speed of its forward motion, which may be anywhere from ten to thirty miles an hour. At the same time it is rapidly whirling on its axis in the opposite direction from a screw, or the hands of a clock, the air revolving around the vortex necessarily attaining a speed of several hundred miles an hour. First widening, then contracting, now bounding above the tree-tops, and again descending to sweep the earth bare of every object within its reach, the aërial monster surges onward. The largest forest-trees, mere playthings in its grasp, are plucked up by the roots, or snapped off like pipe-stems; substantial buildings are first crushed like egg-shells, then caught up in the vortex and the *débris* carried sometimes for miles, before it is again thrown off by centrifugal force, and falls by gravitation anywhere, everywhere, as soon as released from the monster's grasp.

It is difficult accurately to describe the tornado's appearance and work, even for those who have been eye-witnesses, or who have personally passed through the horrors its coming brings. While accounts differ as to its appearance and behavior, as witnessed from different points of observation and under different circumstances, all substantially agree that it is cone-shaped, its motion rotary, that its apex resembles fire and smoke, and that vivid lightning and heavy rain-fall usually accompany it. In rare instances, electricity, in the form of St. Elmo's fire, will precede the vortex, and a white, steamy cloud will follow. It will be observed that the form of the tornado-cloud is nicely illustrated by the "proof-plane" used in teaching natural philosophy. The small end of the plane is most heavily charged with electricity, and,

the nearer it approaches to a perfect point, the greater will be the accumulation: a high tension is caused, and the electricity must escape by some conductor. So, in the tornado-cloud, the smaller the point or stem, the greater the force exerted when it meets the earth.

The bounding or swaying motion of the tornado can be illustrated by the experiment of the "electrical puppets": the cloud above forming the upper plate, and the earth beneath the lower one. All light objects between are drawn up, then thrown down—being first attracted, then repelled.

While the tornado, on its course, possesses four distinct motions—as previously stated—there seems little doubt that the central force, or the one exerting the greatest power, is purely electrical, although the outer surface of the vortex be composed of wind moving at a rate of speed that can scarcely be comprehended.

So many readers are already familiar with statements frequently made regarding the tornado's strange freaks, that a few illustrations only will be given.

Mr. C—— states that, during the tornado which visited Sangamon County, Illinois, on May 18th of the present year, while himself and family had taken refuge in the cellar, a sulphurous smell prevailed, a ball of fire burst above them, and they were severely burned about the face and neck, but otherwise uninjured, although the house was torn from over their heads.

The family of Mr. T——, who had also sought shelter in a cellar from the same storm, were covered with a gummy substance, which would not wash off! This substance might have been formed from the sap of trees and juice of leaves, combined with the moist, heated atmosphere. In passing over the track of the tornado, the writer observed two large elm-trees torn out by the roots; one had fallen to the east, the other to the west, and the tops of both were firmly interlocked. A short distance from these, a white-oak tree, thirty inches in diameter, was broken off and lay upon the ground, the top toward the west; on top of this lay another large tree, which had stood in a northwest direction from the first. The rotary motion of the destructive force was here clearly proved. A thrifty young maple-tree, twelve inches in diameter, stood apart from other trees, near the edge of the storm's track. About six feet from the ground the bark was peeled entirely off for a distance of two feet. No broken limb, or other missile, lay near the tree, and its top was uninjured! Could this effect be produced by wind? Was it not, more likely, caused by concussion?

In the same tornado a whole orchard was swept away; the large trees carried one fourth of a mile, stripped of their bark and smaller limbs, and completely plastered with mud. A wagon-tire was torn from the wheel, straightened out, and driven into the side of a building. A flock of geese were plucked of their feathers, which were deposited in a hedge-fence, giving it a complete coating.

Credible persons testify to having seen a horse carried over the roof of a barn, and again let down, without receiving serious injury. A child's necklace, with locket attached, was picked up in the village of A——, having been carried by the storm from W——, eight miles distant! Mr. and Mrs. T——, living in L——, were both killed, and their house destroyed by the tornado. A vest belonging to Mr. T——, containing valuable papers and a sum of money, was found in the town of P——, twenty miles away, and restored to the relatives of the deceased owner!

Wagons, agricultural implements, and household furniture, will be carried a long distance and broken into fragments by the tornado, while delicate mirrors and sets of glass-ware may be spared. The giants of the forest will be torn to splinters, while the modest flowers beneath them are left blooming as sweetly as if nothing had occurred!

The belief has obtained to some extent that tornadoes follow subterranean veins of water. That they are repeated in certain localities, have a fondness for belts of timber and small water-courses—provided they run in the right direction—there can be no doubt. They also travel over a portion of country previously moistened by rain. This rule has but few exceptions.

The increasing frequency and severity of these visitations (notwithstanding what may be said to the contrary) compel the writer to believe that radical changes are taking place in our atmosphere and climate; that the construction of great railroad-belts across the continent and the erection of a vast network of telegraph and telephone wires exert an influence upon the atmosphere, by disturbing the equilibrium of electric forces. The fact that tornadoes do not closely follow railroad and telegraph lines is not sufficient to disprove the soundness of this theory; and, whether true or false, the fact of the climatic change remains, and opens a vast field for further exploration by the electrician and the meteorologist.

Long-range predictions and weather forecasts may be safely indulged in, if made in a general way; but, when confined to fixed dates and certain localities, they have usually proved a hollow mockery, and brought ridicule upon the authors.

The United States Signal Service has proved to be quite reliable in its observations and predictions of approaching storms, and should receive due credit for its service rendered in protection of life and property. The benefits might be still further extended by a system of railway-express signals, operated in connection with it and by the direction of the Government observers at the different stations. Unfortunately, however, the warnings of this Service can not reach all concerned in time to be of value, nor can it protect in the hour of danger: as witness the tornado which visited the States of Texas, Mississippi, and Louisiana, on the 22d of April, in the present year, by which over one hundred persons lost their lives; also those which

swept over a portion of the States of Missouri, Illinois, and Wisconsin, on the memorable evening of May 18, 1883. By this storm, sixty-five persons were killed and two hundred wounded in the State of Illinois alone; and yet the percentage of lives lost was small compared with the immense value of property destroyed.

As the matter now stands, the tornado seems to remain a problem that baffles science—a veritable despot in the economy of nature. The puny arm of man is powerless against it; no structure he can rear will successfully resist it, coming off unscathed in the conflict; and no device his mind can plan will turn it aside from its chosen course. Experience has amply demonstrated that the safest place in the hour of such danger is found in some subterranean retreat.

HOW THE EARTH WAS PEOPLED.

By M. le Marquis G. De SAPORTA.

II.

IT follows from the exposition given in our former article that man, issuing from a "mother-region" still undetermined, but which a number of considerations indicate to have been in the North, has radiated in several directions; that his migrations have been constantly from north to south; and that they have given rise to races the more ancient of which went farthest and were the most inferior. The superior races were those which, migrating later and becoming localized in peculiarly favorable climatic conditions, have risen gradually to what we call civilization.

M. de Mortillet has occupied himself with this progress, and, persuaded that existing mankind is only a resultant, and the last term of a series of successive transformations, distinguishes between several men, as tertiary man, quaternary man, existing man. The man of the ancient quaternary, the Neanderthal, the Denise, and the Canstadt man, appear to him so different from the historical type, that not only does he separate them from it, but he creates for the times anterior to the quaternary a human or pseudo-human category of a particular order. There were, in his view, "precursors of man," to which he applies the significant name of *anthropopithecus*, or "man-monkey," because he believes they preceded man in the scale of beings, and constituted an intermediate type between the living anthropomorphic apes and man. We should then have to deal with a creature high enough above the gorilla and the chimpanzee to know how to cut flints and use fire, low enough not to be able to rise above that industrial grade and become a real man; or with a race standing to the Bushman and Tasmanian as they seem to stand to us. Theology does not abso-

lutely repel this view, for it discusses the possible existence of pre-adamites. Religion even seems disinterested in the question, for the Abbé Bourgeois, whose discoveries have given rise to M. de Mortillet's anthropopithecuses, and who has not rejected the theory, has always passed for a soundly orthodox priest, while he is known to be a keen observer. Nothing is against an impartial examination of the question. Only the objections may be offered to his views that no one has ever seen an anthropopithecus, the structure and characteristics of which have been worked out by pure reasoning alone, and that the distance that must have separated the precursor of man from man himself is calculated upon the extremely uncertain basis of the distance between quaternary and existing man.

According to M. de Mortillet's admission, quaternary man was himself gradually modified. "His blood," he says, "was infused into the new race, and may even reappear by atavism in our own times." The question is reduced to one of learning whether there existed in Europe, alongside of the miocene anthropomorphs of St. Gaudens, a primitive and rudimentary man of unknown physical qualities, who had industrial instinct enough to cut flints for his use. We are thus brought to the inquiry whether the instruments collected at Thénay by Abbé Bourgeois, and those discovered afterward in Portugal, in more recent but unquestionably tertiary formations, are authentic, or are not simple flakes and natural fragments that have been confounded with articles intentionally fabricated. Thénay, where the earlier of these flints were discovered, is in the Lower Miocene, an inferior formation to that of Sansan, in which the anthropomorphic fauna we have spoken of were included. The existence of the rhinoceros at the time of its formation is still in doubt, the mastodons had not yet appeared, the elephants were still far off; the hipparions, the predecessors of the horse, were not to make their appearance till long afterward. The marsupials had disappeared, and the carnivora were represented only by ambiguous types. None of the animal forms that were to accompany the earlier steps of man, and which he would have to contend against or tame, had showed themselves. Yet man is to be placed, in this rudest condition of nature, already in possession of fire! There is certainly little *a priori* probability of this. To be convinced of it, we need more evidence than has yet been presented to us—a few flints among many thousands of others, that may have been intentionally chipped. This is a little, but not enough, in view of the improbabilities which accumulate, against our putting faith in such indications.

The tertiary flints of Portugal are not calculated to add strength to the conviction. They come from an unquestionably tertiary fresh-water formation of the recent Miocene age. The Portuguese flora of the age was characterized by the presence of elms, poplars, cinnamon-trees, saponarias, and tamarinds, which testify to a mild and equable

climate throughout Europe, in which man would have found conditions most favorable to his development. When, however, we undertake to establish his existence there, we have in evidence only a deposit of sandstone mixed with silicious pebbles, partly disaggregated, which have been submitted to subsequent erosions and atmospheric influences that sufficiently explain the numerous fragments scattered over the ground from which those believed to have been intentionally cut have been sifted after a long search. M. Cazalis de Fondouce, who was a member of the Prehistoric Congress at Lisbon in 1880—a man of acknowledged competence in such matters—visited the miocene beds of Monte Redondo, and justifies his reservation of opinion on the character of the very few flints which it is possible to assimilate with those of the Moustier period, by reference to the denudations and disturbances the beds have suffered. It is not impossible that the stones were cut by man. One of them appears to have been taken from a bed that had not been disturbed; but, if this is admitted, is it not better to wait, than to attempt to solve so great a problem at once and without direct proof? M. de Mortillet is himself wise enough not to affirm directly anything but the authenticity of the instruments. He adds that their small size leads him to believe that the beings that made them, if of proportionate dimensions, were not and could not have been real men. The doubt which he admits respecting the creatures whose intervention he invokes, we extend to the instruments, and wait for the results of future discoveries to resolve it.

Acceptation of these relics as evidences of a tertiary man is made more difficult by the bright light of the following period, which M. de Mortillet calls "Chellean," from the station of Chelles, near Paris, which he regards as typical of it. Man reveals himself in this epoch with an evident industry—primitive, for it presents only a single category of instruments, which are, however, so clearly characterized by their form and size that the most prejudiced mind could not fail to recognize them at once as belonging to the same race. The deposit of Chelles is even more characteristic than that of St. Acheul, where similar instruments have been found in so great numbers. The *Elephas antiquus* of Falconer, the probable ancestor of the Indian elephant, and the predecessor of the mammoth in Europe, is found exclusively at Chelles, associated with human implements, while at St. Acheul the mammoth is more frequently found, although the other species is not absent. Thus, Chellean man saw two species of elephants merge one into the other. Probably, also, the climate changed insensibly and became colder, without disturbance to his habits or his industry. In the long run, however, the action of the physiological and biological events of which Europe became the theatre had an influence on quaternary man; and the Chellean race, passing into that of Moustier, gradually changed its habits, while it learned to fashion other instruments. There need have been nothing abrupt in this evo-

lution, which was the product of the exigencies of a climate gradually growing more severe. At the beginning, the animals, plants, and air were those of Northern Africa, and the conditions for human existence were of the best. The Chellean man lived in the open air, or possibly under light shelters, but did not resort to caves, and was not accustomed to bury his dead. These facts explain the abundance of instruments of that age in alluvial deposits, their absence from the caves, which served as places of refuge in the following ages, and the extreme rarity of bones. The great numbers of the implements found in different parts of France give the idea of an active population of considerable density, whose peaceful extension was not interrupted during long ages by any unfortunate event. The race may be traced by means of identical instruments, except that the materials vary according to the resources of the different countries, in Spain, Portugal, Italy, Algeria, and Egypt, and even at the Cape of Good Hope; and, in North America, in the valley of the Delaware, New Jersey, and the Bridger Basin, Wyoming. The uniformity of the instruments is a most striking feature. Always the same in design, they were made to serve for more than one use—a merit, probably, in the eyes of the men who chipped them out, but a sign of inferiority in the race which, for thousands of years, knew how to make these and no other tools. They were not, according to M. de Mortillet, real hatchets, as they have been commonly called, but simply a tool (*coup de poing*), to be held bodily in the hand, and used according to the need, as hatchet, knife, chisel, or gouge. The weapon of the race was a club, and of that all traces have, of course, vanished.

The slow development of the division of labor seems to have been reserved for the following age, that of Moustier, which joins closely upon the Chellean age, and, while less perfect in details, evidences more skill and rapidity in processes, and a more utilitarian spirit. Its implements are more varied and specialized in their forms. The climate had become more severe; the glaciers were approaching their greatest extension; and "Moustierian man" was obliged to take refuge in caverns, where the relics of his industry are as frequent as those that occur scattered over the soil. In other respects the race and epoch of Moustier seem to have been simply a prolongation of those of Chelles. Only man, under pressure of new necessities, experienced wants he had not previously known. He had to be more industrious. Large animals had become more numerous; he had to arm himself for defense, and became a hunter.

As no pains were taken to give the dead a permanent burial, we can not expect to find many bones of these most ancient races. Possibly their dead were exposed, as those of some Indian tribes are now, and that would be an additional reason why their remains should have utterly disappeared. Leaving out the doubtful relics, M. de Mortillet finds only a very few bones that can possibly be ascribed to the

Chellean epoch. They belong to the race which MM. de Quatrefages and Hamy have determined, from purely anatomical considerations, as the Canstadt race, after the skull found at that place associated with elephants' bones in 1700. This skull, the Eguisheim skull (near Colmar), the fragments from Denise, the Neanderthal skull, and the *la Noulette* jawbone, are all that we have of it, and they are, it must be acknowledged, very little. They are enough, however, to give the clew to its general features, and to show its inferiority to the Bushmen and Australians, more marked, according to M. de Mortillet, than the differences between those races and the Europeans. M. de Mortillet believes that the Neanderthal man was violent and pugnacious, and goes so far as to deny him articulate speech. But we can not indulge in such bold conjectures on so little evidence. We know nothing more of the primitive European man, or of his fate. His simultaneous extension over so large a number of points gives occasion for the thought that originally, at least, he represented, not a particular race, but the common stock, in which modifications were destined to be made according as it became localized and specialized under the influence of the extremely varied conditions of the medium in which it found itself at different places. The Neanderthal man was, then, the original of what has followed. Advancing toward the south, he has peopled the earth, and been divided into local races and tribes. The Moustier epoch illustrates in Europe the stage following the first one; and the periods following that of Moustier, which M. de Mortillet has named Solutrean and Magdalenean, from the typical stations at Solutré and la Madeleine, correspond with the times when man, having localized himself, underwent gradual transformations, assuming in different respects the specific characteristics that distinguish those races, developing aptitudes as diverse as the places in which he fixed himself, and stopping at unequal and successive steps of the ladder which he was destined to climb, but which was to lead him to the full exercise of his noblest faculties only on condition of his reaching its highest rounds.

The Solutrean age was only one of rapid transition to the Magdalenean, and appears to have represented a local rather than a secular development. Both ages are the expression of the increasing cold of the glacial period, during which the huge pachyderms gradually disappeared under the growing rigor of the climate, and the reindeer and horse multiplied to take their places. The reindeer came down to occupy Central Europe, without reaching the southern regions, in numerous varieties, all of which, however, were allied to the existing reindeers of Lapland. Of the horse, at least twenty thousand, possibly forty thousand skeletons, have been found at Solutré. Neither of these animals was then domesticated, and the dog was still unknown. Man secured animals by hunting, either killing them on the spot or binding them to take home. The mammoth had become a

kind of legendary being, hidden in the deepest forests, an object of curiosity, abundant enough to furnish ivory, and to provoke the man of the time to execute drawings of him. In fact, the man of this age had made great progress. The division of industrial labor had become efficient. The cutting of the flints had attained great perfection and delicacy, and a new branch of industry had been added to it; bone was worked, with ivory and reindeer-horn. Both the instruments and the substances of which they were made were now specialized. We have seen points of javelins and darts artistically worked on both faces, and prepared for handles; the scrapers were no less appropriately fitted to the use to which they were exclusively applied. Of bone were made needles, harpoons, and at last purely ornamental articles, sculptures, and engravings. Some of the representations give us curious details concerning the man and the animals of the epoch. The reindeer, bear, and mammoth were figured. The man is always naked, or appears to be. We distinguish the figure of a woman, whose body seems covered with hair; but this may only indicate garments of skins. One of the figures represents a man walking with a club over his shoulder. Men also become differentiated by localization, and the Magdalenean man offers us one of the earliest instances in Europe of this effect. The Solutrean race, whose spear-heads are so finished, and the more recent and more artistic race of the caves of Périgord, whose simple designs and efforts in sculpture we admire, show us the first essays of that spirit of initiative and of relative progress, which, after localization, conducted some of them to material inventions and ideal conceptions, and by these to the region of that supreme culture of all our faculties which we call civilization.

As M. de Mortillet shows, the man of la Madeleine was a hunter, active, ingenious, and susceptible to sentimental impressions from living nature. He had a home, and joys and sorrows; he held his hunting-feasts, and knew how to procure a kind of enjoyment with the aid of the arts of imitation and ornamentation. He recognized rank and a hierarchy, for he possessed emblems of honor and insignia of command. But this was all. He had no agriculture, no domestic life; and, if those men had any particular way of disposing of their dead, it was by exposure in the open air; and this is probably the reason that so few of their remains are found.

Is there any way in which we can determine the physical traits and osteological structure of this Magdalenean race? The numerous remains found at Cro Magnon in connection with articles of the Magdalenean age were thought to belong to the artistic race of Périgord; but M. de Mortillet discredits this opinion by showing that the places where these remains occur were disturbed in the succeeding period, the Robenhausian, and that the burials, unknown to the Magdaleneans, were practiced by those who came after them.

To M. de Mortillet, the European Magdalenean race was only a modified prolongation of that of Chelles and Moustier. Mixtures by migration and the co-existence of several races having differently shaped skulls were posterior to the recent quaternary and to the extinction of the mammoth and the retreat of the reindeer to the north. Then came an age in which, the climate having undergone amelioration, the glaciers having retired to the foot of the mountains, and the sea having withdrawn from Northern Europe to within its present limits, a new era was inaugurated. This was the era of continuous development and activity, the progress of which at last leads us step by step to the invention of metals and to history proper. The last period, however, includes many sub-periods. The metals were still unknown for a long time, and stone continued to be the only material used in making working-tools. A few arts, the necessary point of departure for all society, had, however, begun to be exercised: among them were the domestication of useful animals, beginning with the dog; agriculture, and consequently the adoption of some of the food-plants; the use of pottery; and, finally, the grouping of men and their habitations in view of common defense, and also of the observance of religious rites. To an age of this kind, which has left a host of points in Europe, from Scandinavia to Switzerland, and from the heart of France to Southern Italy, M. de Mortillet has given the name Robenhausian. To follow it on this new ground through its progress to the age of bronze, would require the consideration of details that would carry us too far. It was the age of the dolmens and of the lake-villages; in it man was beginning to grow out of his infancy. Although, at least in Europe, he was not acquainted with the use of metals, and possessed only a rudimentary agriculture and industry, and although his food was still scanty and his existence precarious, he had already begun to sow wheat and barley; he wove coarse linen cloths; he made vessels of pottery and hardened them in the fire; and he built real monuments to his dead, artificial representations of caves made by piling rough stones together. Religious rites and invocations, a kind of luxury in furniture, and medical and surgical processes, came in vogue. We feel that we are on the verge of great inventions and of gigantic efforts, tending to enlarge the formerly extremely narrow circle of knowledge and of processes.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

THE ALCOHOL-HABIT.

I.

IN the tragedy of errors, called the history of the human race, ignorance has often done as much mischief as sin; and the erroneous theories of the cause—and, consequently, the proper cure—of the *Poison-Vice* have caused nearly as much misery as that vice itself. They have made intemperance an all but incurable evil; they have helped to originate the dogma of natural depravity, the confidence in the efficacy of anti-natural remedies, and that baneful mistrust in the competence of our natural instincts that still vitiates our whole system of physical education.

Physiology is a true thaumaturgic science—a description of wonders. The veriest savage must dimly recognize the fact that man can not measure his cunning against the wisdom of the Creator, and, if the development of science should continue at the present rate of progress for a thousand generations, the accumulated knowledge of all those ages would convince its inheritors that a blade of grass is a greater marvel than all the products of human skill. No human artificer can imitate the mechanism of a motor-nerve; the structural devices which the microscope reveals in the tissue of the meanest moss are perfect hyperboles of wisdom and plastic skill. But the greatest miracles of that wisdom manifest themselves in the self-protecting contrivances of a living organism. Our nervous system performs its functions by a combination of alarm-signals that apprise us of an infinite variety of external dangers and internal needs, in a language that has a distinct expression for every want of our alimentary and respiratory organs, for every distress of our tissues, sinews, and muscles, for every needed reaction against the influence of abnormal circumstances; our skin protests against every injurious degree of heat and cold, our lungs against atmospheric impurities, our eyes against the intrusion of the smallest insect; the human body is a house that cleanses its own chambers and heats its own stoves, opens and shuts its windows at proper intervals, expels mischievous intruders, and promptly informs its tenant of every external peril and internal disorder.

How, then, can it be explained that the wonderful architect of that living house has provided no better safeguard against such a dreadful danger as the alcohol-habit? Millions of our fellow-men complain that they owe their temporal and eternal ruin to the promptings of an irresistible appetite—as if Nature herself had lured them

to their destruction. Temperance-preachers descant on the "danger of worldly temptations" and "selfish indulgence," on the "lusts of unregenerate hearts." Drunkards plead their willingness to reform, but "the flesh is stronger than the spirit," the clamors of instinct silence the voice of every other monitor. Does the power of such appetites not suggest the occasional incompetence of our natural intuitions? Does it not seem to confirm the dogma of natural depravity, and prove an essential defect in the constitution of our physical conscience? Nay, in the light of Nature, for reason too often fails to supply the shortcomings of instinct; the teachers whom the ignorant must follow seem themselves to be in need of a guide; the stimulant-vice has found learned and plausible defenders; zealous priests of Moloch have worshiped the man-devouring fire as a sacred flame; for thousands of honest truth-seekers the disagreement of doctors makes it doubtful if alcohol is a friend or a foe, a health-giving tonic or a death-dealing poison.

Does all this not prove that, in one most important respect, Nature has failed to insure the welfare of her creatures?

What it really proves is this: That habitual sin has blunted our physical conscience till we have not only ceased to *heed*, but ceased to *understand*, the protests of our inner monitor; it proves that the victims of vice have so utterly forgotten the language of their instincts that they are no longer able to distinguish a natural appetite from a morbid appetency.

For the Creator has not intrusted our physical welfare to accident or the tardy aid of science, and, in spite of the far-gone degeneration of our race, our children still share nearly all the protective instincts of the Nature-guided animals. Children abhor the vitiated air of our city tenements; they need no lecturer on practical physiology to impress the necessity of out-door exercise; their instinct revolts against the absurdities of fashion and the unnatural restraints of our sedentary modes of life. And the same inner monitor warns them against dietetic abuses. Long before Bichat proved that our digestive organs are those of a frugivorous animal, children preferred apples to sausages and sweetmeats to greasy made-dishes; they detest rancid cheese, caustic spices, and similar whets of our jaded appetites. No human being ever relished the first taste of a "stimulant." To the palate of a healthy child, tea is insipid; the taste of coffee (unless disguised by milk or sugar) offensively bitter, laudanum acrid-caustic; alcohol as repulsive as corrosive sublimate. No tobacco-smoker ever forgets his horror at the first attempt, the seasick-like misery and headache—Nature's protest against the incipience of a health-destroying habit. Of lager-beer—"the grateful and nutritive beverage which our brewers are now prepared to furnish at the rate of 480,000 gallons a day"—the first glass is shockingly nauseous—so much so, indeed, as to be a fluid substitute for tartar emetic. Nor do our instincts yield

after the first protest: nausea, gripes, nervous headaches, and gastric spasms, warn us again and again. But we repeat the dose, and Nature, true to her highest law of preserving existence at any price, and feeling the hopelessness of the life-endangering struggle, finally chooses the alternative of palliating an evil for which she has no remedy, and adapts herself to the abnormal condition. The human body becomes a poison-engine, an alcohol-machine, performing its vital functions only under the spur of a specific stimulus.

And only *then* the unnatural habit begets that craving which the toper mistakes for the prompting of a healthy appetite—a craving which every gratification makes more exorbitant. For by-and-by the jaded system fails to respond to the spur; the poison-slave has to resort to stronger stimulants; rum and medicated brandy now mock him with the hope of revived strength; the gathering night still gives way to an occasional flickering-up of the vital flame, till the nervous exhaustion at last defies every remedy: the worshiper of alcohol must consummate his self-sacrifice, the shadow of his doom has settled on his soul, and all the strongest stimulants can now do for him is to recall a momentary glimmering of that light which filled the unclouded heaven of his childhood.

In order to distinguish a poison-stimulant from a harmless and nutritive substance, Nature has thus furnished us three infallible tests:

1. *The first taste of every poison is either insipid or repulsive.*

2. *The persistent obtrusion of the noxious substance changes that aversion into a specific craving.*

3. *The more or less pleasurable excitement produced by a gratification of that craving is always followed by a depressing reaction.*

The first drop of a wholesome beverage (milk, cold water, cider fresh from the press, etc.) is quite as pleasant as the last; the indulgence in such pleasures is not followed by repentance, and never begets a *specific craving*. Pancakes and honey we may eat with great relish whenever we can get them, but, if we can't, we won't miss them as long as we can satisfy our hunger with bread and butter. In midwinter, when apples advance to six dollars a barrel, it needs no lectures and midnight prayers to substitute rice-pudding for apple-pie. A Turk may breakfast for thirty years on figs and roasted chestnuts, and yet be quite as comfortable in Switzerland, where they treat him to milk and bread. Not so the dram-drinker: his "thirst" can not be assuaged with water or milk, his enslaved appetite craves the wonted tipple—or else a stronger stimulant. Natural food has no effect on the poison-hunger; Nature has nothing to do with such appetites.

The first choice of any particular stimulant seems to depend on such altogether accidental circumstances as the accessibility or cheapness of this or that special medium of intoxication. Orchard countries use distilled or vinous tipples; grain-lands waste their products on malt-liquors. The pastoral Turkomans fuddle with *koumiss*, or fer-

mented mare's-milk, the Ashantees with sorgho-beer, the Mexicans with pulque (aloe-sap), the Chinese and Persians with opium and hasheesh (*Cannabis Indica*), the Peruvians with the acrid leaves of the coca-tree. Even mineral poisons have their votaries. There are thousands of arsenic-eaters in the southern Alps. Arsenious acid, antimony, cinnabar, and acetate of copper, are mistaken for digestive tonics by Spanish and South American miners. By the process of fermentation, rice, sago, honey, sugar, durrha (*Sorghum vulgaris*), dates, plums, currants, and innumerable other berries and fruits, have been converted into stimulants. The pastor of a Swiss colony on the Llanos Ventosos in the Mexican State of Oaxaca told me that the Indians of that neighborhood stupefy themselves with macerated *cicuta*, a kind of water-hemlock, and remarked that the delirium and the subsequent reaction of a cicuta-debauch correspond exactly to the successive phases of a whisky-spree, the only difference being in the price of the tipple. If intoxication were a physiological necessity, it would, indeed, be folly to buy the stimulant at the dram-shops, since cheaper poisons would serve the same purpose. A dime's worth of arsenic would protract the stimulant-fever for a week, with all the alternate excitements and dejections of an alcohol-revel. A man might get used to phosphorus and inflame his liver with the same lucifer-matches he uses to light his lamp; we might gather jimson-weed or aconite, or fuddle with mushrooms, like the natives of Kamchatka, who prepare a highly-intoxicating liquor from a decoction of the common fly-toadstool (*Agaricus maculatus*).

These facts teach us two other valuable lessons, viz., that *every poison can become a stimulant*, and that *the alcohol-habit is characterized by all the symptoms which distinguish the poison-hunger from a natural appetite.* One radical fallacy identifies the stimulant-habit in all its disguises: its victims mistake a process of *irritation* for a process of *invigoration.* The self-deception of the dyspeptic philosopher, who hopes to exorcise his blue-devils with the fumes of the weed that has caused his sick-headaches is absolutely analogous to that of the pot-house sot who tries to drown his care in the source of all his sorrows; and there is no reason to doubt that it is precisely the same fallacy which formerly ascribed remedial virtues to the vilest stimulants of the drug-store, and that, with few exceptions, the poisons administered for "medicinal" purposes have considerably increased, instead of decreasing, the sum of human misery.

The milder stimulants (light beer, cider, and narcotic infusions) would be comparatively harmless, if their votaries could confine themselves to a moderate *dosis.* For sooner or later the tonic is sure to pall, while the morbid craving remains, and forces its victim either to increase the quantity of the wonted stimulant, or else resort to a stronger poison. A boy begins with ginger-beer and ends with ginger-rum; the medical "tonic" delusion progresses from malt-extract to

Munford's Elixir; the coffee-cup leads to the pipe, and the pipe to the pot-house. Wherever the nicotine-habit has been introduced, the alcohol-habit soon follows. The Spanish Saracens abstained from all poisons, and for seven centuries remained the teachers of Europe in war as well as in science and the arts of peace—freemen in the fullest sense of the word, men whom a powerful foe could at last expel and exterminate, but never subdue. The Turks, having learned to smoke tobacco, soon learned to eat opium, and have since been taught to eat dust at the feet of the Muscovite. When the first Spaniards came to South America they found in the Patagonian highlands a tribe of warlike natives who were entirely ignorant of any stimulating substance, and who have ever since defied the sutlers and soldiers of their neighbors, while the tobacco-smoking red-skins of the North succumbed to fire-water. In the South-Sea Islands, too, European poisons have done more mischief than gunpowder: wherever the natives had been fond of fermented cocoa-milk, their children became still fonder of rum; while the Papuans, whose forefathers had never practiced stimulation, have always shown an aversion to drunkenness, and in spite of their ethnological inferiority have managed to survive their aboriginal neighbors. International statistics have revealed the remarkable fact that the alcohol-vice is most prevalent—not in the most ignorant or most despotic countries (Russia, Austria, and Turkey), nor where alcoholic drinks of the most seductive kind are cheapest (Greece, Spain, and Asia Minor), but in the *commercial countries that use the greatest variety of milder stimulants*—Great Britain, Western France, and Eastern North America. Hence the apparent paradox that drunkenness is most frequent among the most civilized nations. The tendency of every stimulant-habit is toward a stronger tonic. Claude Bernard, the famous French physiologist, noticed that the opium-vice recruits its female victims chiefly from the ranks of the veteran coffee-drinkers; in Savoy and the adjoining Swiss cantons kirsch-wasser prepares the way for arsenic; in London and St. Petersburg many ether-drinkers have relinquished high wines for a more concentrated poison; and in Constantinople the Persian opium-shops have eclipsed the popularity of the Arabian coffee-houses.

We see, then, that *every poison-habit is progressive*, and thus realize the truth that there is no such thing as a harmless stimulant, because the incipience of every unnatural appetite is the first stage of a progressive disease.

The facts from which we draw these conclusions have long been familiar to scientific specialists, and have separately been commented upon; but in science, as in morals, the progress from special to general inferences is often amazingly slow. The ancient Athenians would have shuddered at the idea of selling and buying a burgher of their own city, but had no hesitation to enslave the Greeks of the neighboring states. The Romans enfranchised the citizens of Latium, and at last

all the natives of the Italian Peninsula, but kidnapped all the "barbarians" they could lay their hands upon! The French and Spaniards of the last century were deeply shocked at the indiscriminate manhunts of the Algerian corsairs, and even refused to retaliate on the men of Argel, because, in spite of their black turpitude, many of those misbelievers had something like a Caucasian skin on their faces, but those same moralists thought it perfectly proper to kidnap and cowhide the black sons of Ham; but, since the children of a negress were as salable as their mothers, and miscegenation and mistakes could not always be avoided, it sometimes happened that the auctioneer got hold of a white slave, till William Wilberforce at last arrived at the grand conclusion that all human slavery is wrong. More than a hundred years ago, Dr. Boerhaave entered an emphatic protest against rum, French high-wines, and "other adulterated spirits," but confessed a predilection for a drop of good *Schiedam*. Dr. Zimmermann objected to all distilled liquors, but recommended a glass of good wine, and a plate of beer-soup—the latter a Prussian invention, and one of those outrages on human nature that embittered the childhood of Frederick the Great. The hygienic reformers of our own country denounce intoxicating drinks of all kinds, but connive at mild ale, cider, opiates, narcotics, and patent "bitters." The plan has been thoroughly tried, and has thoroughly failed. We have found that the road to the rum-shop is paved with "mild stimulants," and that every bottle of medical bitters is apt to get the vender a permanent customer. We have found that cider and mild ale lead to strong ale, to lager-beer, and finally to rum, and the truth at last dawns upon us that the only safe, consistent, and effective plan is Total Abstinence from all Poisons.

We have seen that the poison-habit is a upas-tree that reproduces its germs from the smallest seeds; but where did the first seed come from? How did the life-blighting delusion happen to take root in the human mind? "Man is the only suicidal animal," says Dr. Haller, "and the first opium-eater was probably some life-weary wretch who tried to end his misery by a lethal dose, and found that his poison could be used as a temporary nepenthe." The physiologist Camper ascribes the introduction of alcoholic liquors to the experiments of unprincipled physicians; but the most plausible theory is the conjecture of Fabio Colonna, an Italian scientist of the seventeenth century. "Before people used wine," says he, "they probably drank sweet must, and preserved it, like oil, in jars or skins. But in a warm climate a saccharine fluid is apt to ferment, and some avaricious housekeeper may have drunk that *spoiled* stuff till she became fond of it, and thus learned to prefer wine to must." Not a compliment to human nature, but quite probable enough to be true. An animal would have preferred water to spoiled grape-juice, but even at a very early period of his development the Nature-despising *homo sapiens* may have learned to

disregard the warnings of his instinct. The economical housekeeper probably thought it a shame that his (giving poor Eve the benefit of the doubt) servants should grumble about a slight difference in the taste of the must, and the servants had to submit, had to drink the "spoiled stuff" again and again, till habit more than neutralized their disgust, for they found that the sickness induced by the effects of the putrefaction-poison (alcohol) could be cured by a repetition of the dose. They began to hanker after fermented must, and, by drinking it in larger quantities, induced a delirium which they described as anything but unpleasant; and their master, after repeated experiments, probably arrived at the same conclusion, namely, that must could be improved by fermentation. The next year they gathered grapes for the deliberate purpose of manufacturing an intoxicating drink, and the fatal precedent was established. Nature exacted the just penalties: the votaries of the poison-god were stricken with physical and mental nausea—weariness, headaches, fits of spleen and hypochondria—but still they found that all these symptoms could be temporarily relieved by a draught of fermented must; and the neighbors were astonished to learn that the servants of Goodman Noah had discovered a panacea for all earthly afflictions. They, too, then tried the receipt—with indifferent success at first, but the experience of the *habitués* encouraged them to persist, till the manufacture of *wine* became an extensive business.

The first traffickers in stimulants (like our lager-beer philanthropists) had a personal interest in disseminating the habit, but, whatever may have been the birth-land of the alcohol-vice, its first growth was probably slow, compared with the rate of increase after its exportation across the frontier. The history of tobacco, tea, coffee (and opium, I fear), has repeatedly illustrated the influence of *imitativeness* in promoting the introduction of foreign vices. The rarity and novelty of outlandish articles generally disposes the vulgar to value them as luxuries, especially while a high price precludes their general use. Foreign merchants and a few wealthy natives set the fashion, and soon the lower classes vie in emulating their betters, the young in aping their elders. In England, James I tried his utmost to suppress the use of smoking-tobacco, but, after his young cavaliers had become addicted to the habit, no penalties could prevent the London apprentices from imitating them. "In large cities," says Dr. Schrodt, "one may see *gamins* under ten years grubbing in rubbish-heaps for cigar-stumps, soon after leaning against a board-fence, groaning and shuddering as they pay the repeated penalty of Nature, but, all the same, resuming the experiment with the resignation of a martyr. The rich, the fashionable, do it; those whom they envy smoke: smoking, they conclude, must be something enviable."

Similar arguments, doubtless, aided the introduction of the alcohol-habit, and, after the vice had once taken root, its epidemic develop-

ment followed as a matter of course. Every poison-vice is progressive, and, soon after the introduction of a new stimulant, the majority of individual consumers will find that the habit "grows upon them," as our language aptly expresses it. The direct effect of the poison, hereditary influences, etc., induce a growing depression of vital energy, which, in turn, leads to an increased demand for the means of stimulation. This want is met in a twofold way: 1. By a direct increase of the quantity or strength of any special stimulant; 2. By the progress from a milder to a more virulent poison of a different kind.

In Prussia, Scotland, Denmark (as well as in some of our Eastern States), actual drunkenness (i. e., intoxication followed by riotous conduct) has apparently decreased, while the revenue register shows an undoubted increase in the *per capita* consumption of alcoholic liquors. This does not prove that our topers are growing less vicious, but that they are growing more practical; intermittent rioters have become "steady hard-drinkers." In the Calmuck *steppes*, whose barrenness has forced the inhabitants to preserve the primitive habits of their ancestors, a little grain is cultivated here and there in the river-valleys, and during the winter migration the herders carry bags full of rye from camp to camp, and bake bread whenever they are short of meat or milk. But at the return of the harvest-season they have both meat and bread, and utilize the surplus of last year's grain by brewing it into a sort of beer, and indulging in a grand carousal—i. e., they get beastly drunk, but only once a year. The Bacchanalia and Symposia of the ancient Greeks were monthly revels in honor of some favorite deity; and even during the middle ages many of the poor Scotch lairds brewed ale only when they expected a guest. To get "as drunk as a lord" was the highest ambition of poor Hodge, but an ambition which he could not often gratify, though he sometimes stinted himself in bread in order to drink his fill—

"At ember-eves and holy ales."

By-and-by, however, wages improved, and *ales* became more frequent and more decidedly unholy, though perhaps less obstreperous, since continual practice enables our topers to "carry their liquor" as discreetly as the Baron of Bradwardine. The most respectable hotel in Geneva, Switzerland, allows its male employés a daily *pour boire* of six quarts of wine; Dr. Buchanan, of Manchester, speaks of English mechanics of the "better class" who take a glass of gin with every meal; and I am sure of understating the truth if I say that in the larger cities of Germany and North America every popular beer-shop has among its customers dozens of "regulars" who drink the year round a daily *minimum* of two gallons of lager-beer. The poison-mania which attacked our ancestors in the form of an intermittent passion has grown into an insatiable hunger; the tempting serpent has become a strangling hydra.

And the heads of that hydra have multiplied. The ancient Greeks knew only one stimulant—wine; the Northmen beer, the American Indians tobacco. We have adopted all three, besides tea from China, opium from India, coffee from Arabia, and fire-water from the laboratory of the German chemists. To this list the modern French have added chloral and *absinthe*. Yet this multiformity of the poison-habit is nothing but a normal symptom of its growth; whenever the quantitative increase of a stimulant-dose has reached its physical limits, the exhausted system craves a new tonic; the beer-drinker rallies his nerves with strong coffee, tobacco, or hot spices (pepper-sauce, "herring-salad," etc.), the brandy-drinker with chloral or opium, the opium-eater with arsenic. "It is alcohol that has led me to opium," says Charles Nisard; "at first I used laudanum only as an antidote."

Antidote means counter-poison. Supplementary poison would have been the right word; foreign poison-habits have supplemented rather than superseded our old stimulant-vices. The brewers' argument, that the use of lager-beer would prevent the introduction of opium, is therefore a bottomless sophism: no stimulant-vice has ever prevented the dissemination of other and stronger poisons. The alcohol-habit has sometimes been supplanted by a passion for opium, chloral, or arsenic, but it can not be exorcised with a weaker stimulant. Beelzebub does not yield to a hobgoblin. Yet nothing is more common in temperance-hospitals than to comfort a converted drunkard with strong black coffee or stimulating drugs, in the hope that the milder tonic might operate as a sort of antidote and neutralize the after-effects of the stronger poison. That idea is an unfortunate delusion. The *succedaneum* may bring a temporary relief, but it can not assuage the thirst for the stronger tonic, and only serves to *perpetuate the stimulant-diathesis*—it prepares the way for the return of Beelzebub with a legion of accomplices. On the total-abstinence plan the struggle with the fiend is sharper, but decisive. If, by the help of a strong physical (or moral) constitution, the drunkard can suppress his appetite for a year, he may manage to keep it afterward in a dormant condition; but only with extreme precaution, for a mere spark is apt to rekindle the flame.

"It should ever be borne in mind," says Dr. Sewall, "that such is the sensibility of the stomach of the reformed drunkard, that a repetition of the use of alcohol, in the slightest degree and in any form, under any circumstances, revives the appetite; the blood-vessels of the stomach again become dilated, and the morbid sensibility of the organ is reproduced."

A young priest from one of the West India Islands once consulted Dr. Rush for an affection of the lungs, and was advised to try the use of garlics. "I am satisfied that your prescription is doing me good," said he at the next interview, "but I wish you would let me steep it in some good old Geneva." "No, indeed, sir!" said the doctor, with

emphasis; "no man shall look me in the face, on the day of judgment, and tell the Almighty that Dr. Rush made him a drunkard!"

I do not intend to deny that the use of mild alcoholic tonics, as a substitute for the frightful remedies of the mediæval Sangrados, is a decided improvement, but, still, it is only a lesser evil, a first step of a progressive reform. Alcohol lingers in our hospitals as slavery lingers in the West Indies, as the witchcraft delusion lingers in Southern Europe. Has alcohol any remedial value whatever? Let us consider the matter from a purely empirical stand-point. Does alcohol protect from malarial fevers? It is a well-known fact that the human organism can not support two diseases at the same time. Rheumatism can be temporarily relieved by producing an artificial inflammation; a headache yields to a severe toothache. For the same reason the *alcohol-fever* affords a temporary protection from other febrile symptoms—i. e., a man might fortify his system against chills and ague by keeping himself constantly under the stimulating influence of alcohol. But sooner or later stimulation is followed by depression, and during that reaction the other fever gets a chance, and rarely misses it. The history of epidemics proves that pyretic diseases are from *eight* to *twelve* times more destructive among dram-drinkers than among the temperate classes; rich or poor, young or old, abstainers are only *centesimated* by diseases that decimate drunkards. On no other point is the testimony of physicians of all schools, all times, and all countries, more consistent and unanimous.

Is alcohol a peptic stimulant? No more than Glauber's-salt or castor-oil. The system hastens to rid itself of the noxious substance, the bowels are thrown into a state of morbid activity only to relapse into a morbid inactivity. The effect of every laxative is followed by a stringent reaction, and the habitual use of peptic stimulants leads to a chronic constipation which yields only to purgatives of the most virulent kind.

Does alcohol impart strength? Does it benefit the exhausted system? If a worn-out horse drops on the highway, we can rouse it by sticking a knife into its ribs, but, after staggering ahead for a couple of minutes, it will drop again, and the second *deliquium* will be worse than the first by just as much as the brutal stimulus has still further exhausted the little remaining strength. In the same way precisely alcohol rallies the exhausted energies of the human body. The prostrate vitality rises against the foe, and labors with restless energy till the poison is expelled. Then comes the reaction, and, before the patient can recover, his organism has to do double work. Nature has to overcome both the original cause of the disease and the effect of the stimulant.

Alcohol has no remedial value. But that would be a trifle, if it were not for the positive mischief which the wretched poison is liable, and very liable, to cause. Four repetitions of the stimulant-dose may

inoculate a child with the germs of the alcohol-diathesis and initiate a habit which years of anguish and despair will fail to cure. By a single glass of medicated brandy thousands of convalescing topers have lost their hard-earned chance of recovery; poor, struggling wretches, swimming for their lives, and, at last approaching a saving shore, have been pushed back into the surging whirlpool, and perished almost in sight of the harbor! The only chance of curing the poison-habit consists in the hope of guarding its victims against all stimulants; and I would as soon snatch bread from a starving man as that last hope from a drunkard.

Abstinence is easier, as well as safer, than temperance. "In freeing themselves from the bonds of an unworthy attachment," says Madame de Sévigné, "men have one great advantage—they can travel." If young Lochinvar's suit had been hopeless, the furtive interview with his lost love might have soothed his sorrow for a moment, but for his ultimate peace of mind it would have been better to stay in the west. The anchorites of old knew well why they preferred the wilderness to the humblest village: they found it easier to avoid *all* temptations. Vices, as well as virtues, are co-operative.

In the cure of the alcohol-habit, the total renunciation of all stimulants is, therefore, the first and most essential measure. A change of diet, a change of climate, of employment, and general habits, will help to shorten the distressing reaction that must precede the re-establishment of perfect health. The force of example may partly supply a deficiency in moral principles, ambition may strengthen their influence. But the effect of any secondary stimulant is more than enough to counteract such tendencies. With the following precautions the total-abstinence plan will prove to have the further advantage of progressive effectiveness; for, after the removal of the irritating cause has in some degree allayed the morbid sensitiveness of the digestive organs, the abnormal appetite will gradually disappear, like the secondary symptoms of the disease, and thus lessen the influence of the subjective temptation.*

THE AIM OF THERMO-CHEMICAL INVESTIGATIONS.

By JULIUS THOMSEN.†

THEORETICAL chemistry is based upon the molecular theory, according to which all matter is made up of molecules, and these molecules of atoms. The physical state of bodies depends upon the arrangement and motions of the molecules; the other physical and chemical properties depend upon the kind and number of the atoms in the molecule, upon their arrangement and relative motions.

* The treatise on "The Alcohol-Habit" will be concluded in our next issue.

† Translated from the introduction to Thomsen's "Thermochemische Untersuchungen," Leipsic, 1882, by W. R. Nichols.

Every action which causes a change in the internal structure of the molecules is a chemical action. These changes may be of various sorts: either there takes place simply a change of position among the atoms of the molecule and there is then formed a body which is isomeric or metameric with the original substance; or the molecule is broken up into several molecules, and the process is then one of dissociation, or of simple decomposition; or, further, several molecules unite together to form a single molecule, in which case the process is spoken of as one of condensation or addition; or, finally, molecules act upon each other with interchange of atoms and formation of new molecules, which is the phenomenon of mutual decomposition, the most common sort of chemical action.

From the doctrine of the conservation of matter, it follows that the mass of the bodies which take part in any chemical reaction does not change, and is fully accounted for in the products of the reaction: this principle forms the foundation for quantitative chemical investigations into the composition of substances.

From the principle of the conservation of energy, it follows, in like manner, that no energy is lost or created, and that, consequently, the whole of the energy originally present in the bodies, which act upon each other, appears again in the products of the chemical reaction, although often in a different manner than before. This principle forms the foundation of all quantitative thermo-chemical investigations.

The energy of a molecule is always the same at the same temperature; any increase or diminution of the energy of the molecules, without change of their internal structure, manifests itself as an elevation or a lowering of the temperature of the substance in question.

By chemical action, the structure of the molecule is changed, the atoms become grouped together in a different way, new relations manifest themselves among them, and the energy of the new molecule becomes different from that of the original one. The simplest case is that where the only change is in the grouping and the motions of the atoms of the same molecule, that is where an isomeric compound is formed; in such a case the atoms of the molecule pass from one condition of equilibrium to another, and, according as the new condition of equilibrium answers to a greater or less stability than the original, there occurs either an evolution or an absorption of energy, and the temperature of a corresponding body changes; in the first case it rises, in the second case it falls.

The chemical action, the passage from one isomeric condition to the other, is therefore accompanied by an evolution, or by a disappearance of heat, according as the attractions of the atoms are more fully or less fully satisfied in the body in its new condition.

The case is similar in other chemical actions; if the molecules of the substances produced by the reaction contain at the same temperature a smaller total energy than the molecules of the bodies acting

upon each other, then the chemical action is accompanied by an evolution of heat; in the opposite case, an absorption of heat takes place. The greater the difference, the greater also will be the change of temperature accompanying the process, so that, if the action takes place rapidly, the temperature may reach that of a red heat, as a result of which the chemical action assumes the character of combustion in the more limited sense of the word.

The aim of quantitative thermo-chemical investigation is now, in the first place, to measure those quantities of heat which are evolved or absorbed in chemical actions. It is true that these values furnish no direct information as to the magnitude of the forces which are concerned in the chemical action, partly because they are merely an expression for the difference between the energy of the molecules decomposed and that of the molecules formed, partly because they are often affected by other actions which accompany the chemical process; they furnish, however, the material for theoretical investigations—for *the higher aim of thermo-chemistry is to establish the dynamical laws of chemical action and to afford an insight into the mysterious region of the constitution of chemical compounds—that is, of the molecules.*

Up to the present time, an almost impenetrable veil has enveloped the internal structure of the molecules and the true nature of the atoms: we know, at the most, the relative number of the different atoms in the molecule, the relative mass of the molecules, and of the individual atoms, and the presence of certain groups of atoms (radicals) in the molecules; but we know almost nothing about the nature of the forces which dominate in the molecule, and which cause the formation and decomposition of compounds.

Experience teaches that the different atoms exert an influence upon each other, which seems to be independent of their mass and which appears now as attraction, now as repulsion, and that the combining capacity of the atoms does not extend beyond a certain limit; still, up to the present time, no satisfactory explanation has been offered for these, the chief phenomena of chemistry. Chemical processes consequently do not as yet admit of a mathematical discussion in their entire extent, as is the case, for example, with the phenomena of physics and astronomy; for the general mathematical discussion of chemical phenomena we lack that which is most important as a basis, namely, a knowledge of the fundamental laws which govern the actions of the atoms. With each decade, however, chemistry approaches nearer and nearer the exact sciences, and already many laws of wider or narrower application are being established on the basis of experiment. The extremely rich and varied material of chemistry now arranges itself in large groups, the members of which follow certain common rules or laws, with reference to their formation and decomposition, and whose properties may be, to a certain extent, deduced from the composition of their molecules.

There is, however, probably no doubt that the mutual action of the atoms, their attractions, and their unequal combining capacity—in short, that "affinity" follows the general dynamic and static laws of mechanical phenomena, and that, in chemistry, as in mechanics, the right of the stronger prevails; with this assumption, general dynamic and static laws may be developed for the phenomena of chemistry, although the real nature of "affinity" is still entirely unknown.

THE HISTORICAL DEVELOPMENT OF MODERN NURSING.*

By ABRAHAM JACOBI, M. D.

NURSING is as old as the human species. Even among animals, such as they are at present, we find occasional sympathy with fellow-suffering, and meet with efforts for the purpose of relief. We can not imagine that human beings, in ever so remote prehistoric times, should have lived together, or near each other, without mutual attempts at relief, when suffering or sick. But this is presumption only, not history. No book, no tradition refers to facts in regard to the subject until the times of ancient Hellas and its successor in civilization, ancient Rome. Antiquity yields but few proofs of systematic nursing. It is true, hospitality was the pre-eminent virtue of the Greek. The stranger was always welcome. If he was sick, he was doubly so. In all Hellas poor sick citizens found ready admission to and nursing in the houses of the rich. It may be that the facility of finding private relief on the part of the sick was one of the causes why no systematic and collective efforts for the purpose of attending and nursing the sick were ever made to any extent. That such was the case, there can be little doubt; for the temples of Æsculapius and the adjoining residences of the physicians were probably not hospitals, but temporary domiciles for those who congregated in large numbers around the homes of the gods. Of the same nature was the edifice erected by Antoninus Pius near the temple of the Epidaurian Æsculapius. In Italy, also, the temple of Æsculapius, on the island in the Tiber, between Rome and the outlet of the river, was never of much importance as a hospital or sanitarium. The only real hospitals at all comparable with institutions such as we have, existed in favor of human property, and for the benefit of soldiers. According to the testimony of Columella, Seneca, and Celsus, the Romans had hospitals for slaves, warriors, and gladiators. In Greece, also, as early as the period of

* Address delivered at the first commencement of the Mount Sinai Training-School for Nurses, May 12, 1883.

Solon, those injured on the battle-field were attended and nursed at the expense of the community. Of the great Cæsar it is well known that he had a regular medical service in his armies.

There is a word in the ancient Greek which has given rise to the belief that Hellas may have had hospitals. But, as no facts and reports sustain that supposition, it is probable that *ἰατρεῖον* meant a medical office, a policlinic, perhaps, but not a hospital. Real hospitals were not built by either Greek, Roman, or Hebrew. The commonwealth of the latter was hierarchic and intolerant. The stranger—though he who was permitted to live in Judea was to be treated like a member of the community—was to be exterminated, and must not be spared. Thus, while there are no proofs of the existence of hospitals for the friend, a painstaking care in favor of the stranger was out of the question.

Antiquity, however, is not without its humane culture. The reconciling feature in that immense picture of indifference and thoughtlessness is found in Buddhism. We have the reliable report of a genuine hospital founded by a king in Ceylon, in the fifth century B. C. One of his successors in the second century B. C. is credited with eighteen hospitals under regular medical superintendence. In the East Indies hospitals are mentioned in the third century. Nor have other civilizations been slow in outgrowing the humane exertions of Hellas, Rome, and Palestine, for Prescott tells us that there were hospitals in Mexico before the Christian Spaniards introduced the blessings of torture, inquisition, and extermination. And when finally the Christians, in the second century after Christ, bethought themselves of the poor and sick and established hospitals, the largest and most effective ones were founded in Asia Minor and Persia, where Buddhism had prepared both means and public opinion—Buddhism, under whose beneficent rules aiding the poor and nursing the sick were two of the religious duties of kings and princes. Nor has Christianity the claim of having the first *large* hospitals. The Arabs had many good and large hospitals about 1200. Cordova, in Spain, sustained fifty within its own walls.

The first information in regard to Christian hospitals dates back to the second century; other reports go back as far as the fourth, and a few others to the sixth century. In most cases the establishments were not exactly hospitals, but stopping-places and dormitories for pilgrims on their way to Rome. To what extent such institutions were necessities is best proved by the order of the so-called "Bridge-makers" (*Hospitaliers Pontifes*), whose original vocation it was to protect pilgrims from the robberies and rapacity of the ferry-men on the large rivers. They existed a long time, became rich and degenerated, and were finally dissolved in 1672 by Louis XIV.

The hierarchic character of the institutions calculated to benefit the poor remained intact until the period of the Crusade wars. At

that time Italian and German merchants initiated the great combinations of the several orders of Hospital Brothers.

Their efforts were not isolated or altogether premature. For there existed a humanistic movement among the better classes of the Occident, on a Christian basis it is true, but spontaneous. Particularly in the cities, societies were formed for the purpose of nursing the sick and aiding the forlorn. Guy, of Montpellier, France, established a hospital in that city, *of larger size*, while up to that time all the institutions of a similar character were small and unavailing, and located outside the walls. The new hospital in Montpellier, and seven more French houses, and two under the same direction in Rome, are first mentioned in a bull of Pope Innocent III, in the year 1198. The secular character of the institutions was at that time fully recognized. In connecting four clergymen with them he commanded that they were to attend to spiritual duties only ("*sine contradictione et murmuratione*"), and not to interfere with the office of the superiors. In 1204 the same pope recognized the newly established Hospital of the Holy Ghost, on the old Tiber bridge, in Rome. With the peculiar mixture of ferocity and mildness so common to the mediæval age, the same man who humiliated emperors, dethroned kings, and persecuted the French heretics with fire and sword to extermination, looked for the helpless and sick in the streets and saved illegitimate babies from their watery graves. Guy de Montpellier's creation, the Order of the Holy Ghost, did not remain long in its original condition. Pope Gregory X (1271–'76) subjected all the houses belonging to the order to the one located in Rome, the first step in the attempt at depriving the order and its hospitals of their secular supervision. It was finally disposed of by the bull of Pope Sixtus IV, of the 21st of March, 1477. Meanwhile and afterward the order spread over all Europe. With its increasing wealth and power it degenerated in the seventeenth century. Though clerical by name, it was the most secular of all the institutions of dissipation. Grand-master and officers lived on the fat of the land and their immense income. In vain Louis XIV attempted to abolish it. The only change French royalty could work was its transmutation into a royal order. In some of the provinces laymen had succeeded, however, in controlling the management. Thus it was in many parts of Germany, where, between 1400 and 1600, several of the institutions belonging to the order were secularized. In Italy, however, the Order of the Holy Ghost remained exclusively clerical. As late as in the beginning of the eighteenth century it had great possessions in Europe and the West Indies.

The Order of St. Elizabeth was founded in 1225 by Elizabeth, daughter of Andrew II of Hungary, and wife of Landgrave Ludwig of Thuringia. Women need not complain that domestic virtues do not warm more than their own home, and do not immortally challenge the admiration of posterity. Her name will never die, when many a great

warrior's memory will be buried out of sight. She founded two hospitals in Eisenach, and another in Marburg, into which the twenty-two-years-old widow retired. The rule was to nurse the female sick only. But when Francis-Joseph and Windischgrätz (*par nobile fratrum*) let loose their Croats over unhappy Vienna, in our own times in 1848, the Sisters of St. Elizabeth were in the front ranks bringing aid and comfort.

In 1171 the orders of St. Protais and St. Gervais were founded in France. About the same time, the houses in Roncesvalles and Burgos. In 1409 José Gilaberto established an order in Valencia for the special purpose of nursing the lunatic.

Those I have mentioned, with several others, were orders founded by the Church, or whose supervision soon became clerical. Those which, though all of them were anxious to submit to the Church, for spiritual reasons, succeeded in retaining their autonomy, must be credited with more real success in accomplishing their ends. Among the first we have any information of is the order of St. Catherine. Its members nursed poor and strange women and girls three days, and buried those who died in prisons or in the streets. In those good old times to which many dissatisfied hearts of to-day look back with longing eyes, those good olden times with their innocence, simplicity, and piety, this dying in the street was of common occurrence, and the Sisters of St. Catherine had plenty of work. We have not only accumulated seven more centuries, but gained more safety, more comfort, and more confidence in the future of mankind.

In the Hôtel-Dieu, the immense Paris hospital, thirty-eight men and thirty-eight women served as nurses. The places were, in later centuries, filled by Sisters of Mercy.

The Brothers of Mercy were founded in 1534 by Juan di Dios (John of God) in Granada. They were laymen, entered the order at between eighteen and thirty-one years of age, and nursed the sick of every faith and creed. Within a hundred years they possessed 18 hospitals, and there was a time when in Spain and the West Indies they had 138 hospitals, with 4,140 beds, and 47,000 sick annually, and in the rest of Europe 155 hospitals, 7,210 beds, and 150,000 sick. Twenty-five years ago they had in Austria alone 29 hospitals, with 20,000 patients.

Of similar character were the Obregons, founded about 1600, with their complicated duties of nursing the sick, praying, and repenting. This multitude of duties must have crippled their efficiency ; they can not compare with the Brothers of Mercy.

The "Bons Fils" (Good Boys) were founded in Flanders in 1615. They were tradesmen, with the duties of nursing the sick, mainly the alienated in their homes, and giving elementary instruction.

The Confraternita della Perseveranza was established in Rome, in 1663, for the purpose of caring for the strangers in the taverns.

The Order of the Sisters of Mercy was founded in 1617 by Vincent de Paul, a preacher. In a sermon he placed before his congregation the case of a poor and sick family, urging their co-operation and sympathy. Enthusiasm and much zeal were roused, and a noble and gifted woman, Louise de Marillac, the wife of Legras, the secretary of Mary of Medicis, enlisted herself at once in the service of that family and of many equally indigent. She and her friends worked both in private residences and in hospitals, and were soon recognized as an order. As early as 1636 a house was founded for the care and education of children and women, a foundling hospital was established, and a home for the alienated in 1645. Her order owned, after a single century, 290 stations, and had 1,500 members, who entered between the ages of eighteen and twenty-four, bound themselves for life to the order and the Church, and worked in hospitals and private residences, in the interest of both women and men, in rescuing fallen girls and educating the young. In Rome, mainly in this century, they assisted those taken with infectious and acute diseases who could not be admitted to the public hospitals, and everywhere they attended the chronic cases of sickness of all denominations. Their foothold in Germany dates from this century only. Their greatest adversity was the all-purifying thunder-storm, the French Revolution. Many emigrated to England, but during the Napoleonic wars their services were so much appreciated as to procure for Sister Martha the cross of the Legion of Honor.

All of the orders mentioned were composed of Catholics. Not one of them but was intimately associated with the Church. In this connection it ought not to be forgotten that all the culture and knowledge of the mediæval period was confined within the limits of the Church. Within its fold the whole progress of mankind, slow though it was, toward humanistic evolution, was developed. Thus the efforts of the Catholic Church in favor of the poor and sick must be duly appreciated, the more so, as the so-called "Reformation" party exhibits nothing but blank leaves in the history of ethical and humane development. The revolutionary movement prepared by powerful minds for centuries, and finally carried out by Luther, did not result in any good to the sick and poor for a long time. Indeed, the success of the Reformation was in part due to the greed of German princes, who gained a rich harvest by appropriating monasteries, hospitals, and all other possessions of the Catholic Church. Thus the Lutheran Church, or churches, were left so poor that if they *had* the will they had not the *power* to make any pecuniary sacrifices in the interest of the poor and sick. But *even that will* they had not, could not have. For the first axiom in Luther's doctrine was this, that *not work performed, but faith only*, made the Christian. That doctrine was a long stride backward; it fired the imagination of some bigots, chilled the hearts of most men, sustained the egotist, and created dissensions. Never was there a

greater failure. The poetry of the Church gone, its efficiency gone, that was the "reformation." Not until some decades ago did we know of Protestant unions established on the plan of their Catholic predecessors. But the *male* orders never tried to imitate the useful example of the Catholics. *They* did not care for the sick or the poor. *Their aim* was and is "home-mission." *They* are replete with faith, distribute Bibles, and glory in the conversion of that Jew who was baptized, once or often, half a dozen years ago, for ready cash. The women, as always, have done better. Their hospital orders, mainly the Deaconesses, have done good work this half-century, both in public institutions and in private. During the war-times in Germany they and other associations established on similar plans did good work, and deserve all the praise bestowed upon them. Their recognition was complete. Princesses joined hands with them—the Archduchess of Baden, Princess Alice of Darmstadt, the Empress Augusta. And not only in military hospitals did they earn deserved praise. Some general hospitals, such as the Augusta Hospital in Berlin, derive great benefit from their incessant and intelligent labors. I do not mean to stint praise, and therefore make this statement of their work, which has been performed under apparently great difficulties. These difficulties are the very rules, for instance, of the Deaconesses of Kaiserwerth, from which I quote for your edification the following introductory paragraph :

"The Christian women who wish to undertake the office of a nursing sister, as deaconess for the sick and poor, must possess a somewhat advanced Christian knowledge. Mere church-membership, mere attendance on Christian assemblies, and reading of Christian works of edification, are not enough. The love of reading the word of God, and a diligent use of the same for a long time past, must exist, as well as a knowledge of the more important histories of the Old and New Testaments. There must also be a knowledge of the sinful heart from their own personal experience, as well as experience of the grace of Christ, in order that they may have learned to despair of themselves, and in their weakness to trust only to the strength of Christ. A Christian walk of life must for a long time have adorned such Christian women," and so on, and so on. You will admit that in the face of so much hyper-religious sentiment an active, unselfish, modern woman must feel bewildered.

After all I have said, it is evident that the cause of humanity was originally not hampered by the efforts of the Catholic Church. On the contrary, many centuries ago it was the only safe deposit, inasmuch as the Arabs lost their importance in humanistic evolution from the fourteenth century, for the gradual development of human feeling. But that human feeling was not fostered and protected because it was human; the Church had but one purpose, the aggrandizement of the Church. The latter has a meaning in the case of the Catholic Church, which is at least a union, and has a uniform standard, which

Protestantism never had and never can have. The latter has, in its imitation of the ways and words of the mediæval rules of Catholic orders, proved one truth, and I emphasize that because here is the great difference between church nursing and modern nursing. "Clerical care of the sick is destined, under the rules, to serve the Church, whatever that may mean, while serving the sick; the main duties and aims in view are ecclesiastical, and not humane, and, instead of a nurse solely given to the performance of her duties, you deal with ecclesiastical officers" (Virchow). And the necessity is clear, that whatever organization is deemed advisable in the interest of the sick, that organization ought to be in our times *un*ecclesiastical and unsectarian. I have alluded to the fact that whatever medical knowledge existed in the masses centuries ago did so through the medium of the clergy. That knowledge was but trifling, for the ancient medicine of the Greeks and the more recent labors of the Arabs were sealed books at that time. But, then, the clergyman was the doctor. Instead of being so at present, we are daily met with the fact that the exact tendency of modern medicine is an unknown territory to the clergy, and that among them the upholders of all sorts of doubtful practices find their most sincere supporters. Medicine is to them a matter of faith, not science. It is not necessary to refer to that Brooklyn impostor whose criminal career has been detailed but lately in the secular press. For no church and no denomination must be held responsible for his methods of fleecing the ignorant and credulous. But the instances where actual clergymen assume responsibilities beyond their clerical powers and duties are also very numerous, and the protection by the Church of a regular monk in a Jersey monastery, who, in the church of his own institution, plies his nefarious trade of laying on hands, and exorcising the devils of disease for cash, these ten years, proves to what extent faith can be abused and the essence of religion distorted. We still live in a time when mediæval ignorance and modern enlightenment appear to find resting-places side by side. That the latter is getting the upper hand, after all, this sketch will prove, I hope, for even the mediæval organizations in the interest of the poor and sick, which I was anxious to estimate at their full value, have finally failed ignominiously. Almost every large society of the kind would degenerate in the end. The uniform report concerning most of them, mainly the male orders, is this, that with increasing power and wealth the original unselfishness of the founder disappeared, the actual work was left to low servants, the wealth of the community was accumulated in the Church. Thus it was that every great calamity sweeping over the lands was a source of riches to the Church. Never was divine blessing more visible in the Church than when half the population of Europe succumbed under the destruction of the "black-death." Never was more business shrewdness developed by "fathers" and "brothers" than when a patient, sick with leprosy—much less contagious than was made

out by those who had an interest in exaggerating its dangers—had to give up half his property before being permitted to bury himself for life in the out-of-town places provided by the Church. The omnivorous taste and good digestion of the Church have become proverbial.

The majority of the clerical associations having failed, the seventeenth and still more the eighteenth centuries were far behind former periods in regard to systematic nursing. It has taken a long time between the church institutions, which no longer came up to the intentions of their founders, and the spontaneous efforts of free men and women who felt the necessity of appropriate efforts on a different basis. The history of this slow evolution is very interesting; it is the co-ordinate of the history of a healthy and wholesome individualism in general, after long indifference and chaos.

Schools for training nurses were established in Germany fifty years ago; in Berlin by Dieffenbach, Kluge, and Gedike, and in Göttingen by Ruhstaat. Books to serve the purpose of instructing nurses and the public in general have been written by numerous men and women, some of them, particularly in our days, by celebrities. Gedike himself published a work, fifty years ago, which is a very readable one even now. Passing by Nightingale, who has proved how to become immortal without enjoying high office, or playing on cannon, or tyrannizing nations, or being borne on a throne, let me allude to but a few illustrious names: Nothnagel, who wrote on the nursing of those sick with nerve-diseases; Billroth, who published a book on nursing in general; Esmarch, who taught the first aid in emergencies; and the greatest of the many great men of the century, Virchow, with his many contributions to the literature of the subject, and mainly, in 1869, with a lecture "On the Instruction of Women in caring for the Sick outside the existing Ecclesiastical Organizations."

This instruction of women in caring for the sick, and the relation of women to nursing as a profession, can be considered from two distinct points of view: first, in its influence upon them; second, in its effects upon the public.

The first consideration is a very important one. The opposition to women stepping out of their sphere, which was meant to be cooking and washing, knitting and darning, begging alms and taking a daily whipping, also getting married and raising a family, has been overcome by common sense and habit. Common sense ceased to understand why or how every woman could or should cook and wash, knit and darn, beg alms, or get whipped or married. And habits are formed and reformed with such rapidity that opposition becomes changed into favor in a few years. It is but little more than a dozen years since women physicians were recognized by the profession; not over half a dozen years since you heard of women lawyers. The female part, and, for that matter, the male part of my audience also, are sorry they heard so much of a

woman lawyer in a Western town. At all events, the opposition to the attempt at widening woman's sphere, or spheres, has ceased, and the recognition of the principles of equal rights, no matter for what color or sex, or previous servitude, is all but universal.

You will not care to go into the question now, whether law or medicine will ever be resorted to by women to any great extent. The entire liberty given them has proved already, will prove more in future, that neither law nor medicine is an appropriate vocation for any but an exceptional class of women, and that the opposition to women practitioners of law and medicine will come less from the professions than from the public. For the public will never admit that a person in the practice of a profession should not give his or her entire attention and strength to it, and the women of the country will never admit that the superintendence of a home and the proper raising of a family are not sufficient employments of all the time and all the powers of the most gifted woman. The amateurs are losing ground. Thus it is that the professions will never be overrun, and the fear of undue competition has long died out, even among the most chicken-hearted braves of the professions. But the question is not how many women will avail themselves of the opportunities granted, but whether they shall have those opportunities, and whether these shall be given the women of all walks of life, of all standards of intellect. And the question has generally been answered affirmatively, to such an extent that it is considered self-understood that, while the mediæval ages attempted to help them as much as possible, modern times prefer to give them the power to help themselves. In regard to nursing, attention was called early to the unmarried and poor among the women. The statistics of Berlin, of the year 1872, proved that every third woman had to provide for herself. It was remarked with surprise that, of 407 such helpless and breadless creatures, but a single one went into nursing as a business. In other Continental cities it was still worse. In Vienna the shiftlessness of women was still greater; misery and poverty reigned supreme, as must be expected when you learn that a woman who took the making of her own clothing, even *with the aid* of a professional seamstress, into her own hands was punishable under the law.

The proportion of but one nurse to 407 women, who had to work for a living, is remarkable, it is true. For are not nursing, and caring, and attending implanted in woman's nature? What is the reason that so few went into nursing as a business, if not a vocation? Probably, because the women felt, or the public made them feel, that without careful preparation no nurse, or *soi-disant* nurse, can be efficient. We have still the remnants, I fear numerous ones, of that self-made class of nurses among us. In my own recollection of far-away years I remember a great many, and a great many, I was told but lately, remember me also, perhaps too well. Some of you may have seen

them—in other people's houses—wrinkled prematurely, thinned out by temper, contrary by nature, or for the most part fattened in the course of their (to them) useful career, complacent, and drowsy while everything was going well, incompetent and snappish when danger required work and sufficiency, always ready to have their regular meals served up-stairs by the help of the house, who breathed freely when they finally left, and always willing to spend their time between rocking a baby, speaking of their long experience, sleeping ten hours, talking gossip all day long, and drinking eleven cups of coffee in the twenty-four hours. This is hardly an exaggeration, for the number of women who took up nursing as a business, driven to it by some natural disposition, gifted with some intellect, modest and willing to profit by superior knowledge and experience, interested in the welfare of their patients, and never stunted in their human feelings by the force of habit, was rather small. But I am glad to say I knew such, too. I gladly shook their hands when I happened to meet them on a common errand, gladly recognizing the diploma they carried in their brains and hearts. But these exceptions proved the rule, and the rule conveyed no blessing. It was, it is, a sad fact that nursing all over the world grew worse in just the same time when medical science grew more exact and medical practice more effective.

Relief in this city came none too soon. The president has detailed to you the history of the training-schools of New York. Since their time the practice in hospitals and in private dwellings has changed wonderfully. After thirty years' work in the city, after twenty-five years' constant labor in public institutions, I ought to know the difference. And I do know and publicly proclaim that the results of the best of physicians have vastly improved since their cases have been in the hands of trained nurses. This is so in private dwellings; it is the same in hospitals. In the hospitals the difference can be measured on a large scale. In them the trained nurse has worked a vast improvement.

Every large hospital ought to perform a double duty. It must give the poor patient, and many rich also, the best possible chance of recovery from sickness. It can afford to accomplish that, because of its pecuniary and intellectual means. Though a hospital be poor, there ought to be, there generally are, means enough to fill all the necessities required. And the intellectual means are expected, are supposed to be, above the average of the general practitioner. There are a great many reasons why that should be so, why hospital places should be open for the competition of the best material among the medical profession, recognized to *be* the best by the medical profession *itself*, and why family and personal influence should not fill places which are better not filled at all than with indifferent or bad material. A hospital must also grant the best possible nursing—attached, wakeful, careful. All this is due to the single patients.

A good deal more, however, is due to the public at large. A hos-

pital looking for the interest of the single patient only might just as well be a private institution, a *maison de santé* for the benefit of a landlord. The benefit derived from hospital treatment by a sick person is not all the satisfaction due to a public who pay four hundred dollars a year for every bed. Nor are the public paid sufficiently for their sacrifices by the accumulated experiences of a few physicians, who enjoy the large field of observation and the opportunity of utilizing it for the benefit of private patients. Every hospital which neglects to increase the stock of medical knowledge, and to give an opportunity of learning the theory and practice of nursing and caring for the sick, performs its duties but half, and serves the public but incompletely. Every large hospital must be, and will be, a clinical school, and a school for nurses. It will be acknowledged that as the presence of a nurse in a sick-ward, who is sent there to learn, is considered unobjectionable, the presence of a few physicians observing a case, which can not be injured by their so doing, is not only not injurious, but ought to be demanded by the public, who have a right to expect a physician in their own families who has seen and knows and understands what he is called in to treat. I do not see why hospital patients only should have the best money and service can afford, and why the public at large should have to fall back in many cases on untried skill. Thus the people have a right to demand that every large hospital should have a clinical school, and a training-school for nurses. The public, who are willing to pay for it, may also demand that the expenses of the same, particularly the nurses' school, should be borne by the hospital. This demand, if considered theoretical only, must stand as long as a hospital is, or claims to be, a public institution. When the board of directors of any institution will recognize that they are not the administrators of the dollars of a small concern, but the benefactors of the public at large, they will also appreciate not only that a few disinterested ladies will open their pocket-books, and collect voluntary contributions, but that a generous public will pay more willingly and more largely.

The demand that a large hospital should be a clinical school and a school for nurses, and that the expense should or might be borne by the institution, is not valid in the case of city or commonwealth hospitals only. Most of the hospitals of the country are originally private institutions. They obtain the character of being public affairs when an always increasing number of men and women become interested in and contributors to them. An institution with one or two thousand paying members represents ten or twenty thousand families —in fact, represents a city. And what it represents, of that it assumes the rights and duties. And the main duty the public at large will soon know how to enforce from the directors of every large hospital is, to administer the public domain to the greatest possible advantage for the greatest possible number. The selfishness of an individual adversary, the animosity of evil-spirited persons will never weigh,

ought never to weigh, against the public good; the latter only is the object of those who are placed in trust of money, institutions, and the public welfare, because of their actual or supposed public spiritedness and superior intellect.

Is it necessary to detail the advantages of the services of a trained nurse over those of an untrained one? The latter class, as a rule, brings to their work no previous education, no theoretical schooling, no technical experience. They come mostly from inferior walks of life, with less intellectual power, and less moral force. Only those who come from better stock, and raise themselves to higher ambitions, will spend money, and two years of their lives, for the purpose of learning both theoretically and practically the art of relieving the sick, aiding their comfort, taking responsibilities which sometimes are as difficult as they are life-saving, and obeying orders with intelligence and understanding. That such persons are valuable additions to our hygienic requirements and sanitary progress everybody can conceive. That without them many a case would not recover, in spite of the most competent medical skill, all of you may have experienced. I, for one, know from personal experience that many a case can be, has been saved, first by the medical orders; secondly, and often mostly, by the execution of orders, such an execution as is rendered possible by combined knowledge and skill only. If I say that we practitioners have commenced to feel safe in regard to many of our cases only since we could rely on the co-operation of a trained nurse, I express but a common observation. I trust that there are households within hearing which know how to appreciate the services rendered them by a trained nurse.

So much only in regard to individual cases. But the service to the public at large hitherto rendered, and constantly increasing, is of a different and still more important nature. Who is nowadays the teacher of the public at large in sanitary matters, in hygienic rules? The knowledge of the Church, when *it* nursed, was faith, and, let us add, in its best times, love. The knowledge of uneducated women was, and is, ignorance driven to actual or alleged work by starvation. The knowledge of a trained nurse is the result of a two years' study under competent teachers, and a constant practice. Who in the community is her superior in the knowledge of the facts mostly necessary for the health and life of your children, and dear ones in general? The clergyman is no longer the teacher of the mysteries of life and common sense. The schoolmaster or schoolmistress knows about the classics, geography, and arithmetic, but no normal school ever taught them the elements of applied physiology. The educated member of any profession except the medical has not the slightest idea of the necessities of the body, the action of food, the effect of clothing, and the hundred facts required by different ages, conditions, and states of health. With the exception of the physician, whose advice is frequently sought only

to repair the effects of ignorance, the only teacher the public have, and will have, is *the trained nurse.* Ten or twenty families may enjoy her presence annually, ten or twenty mothers will learn simple and important truths, knowledge will increase, and prevention of disease will become a possibility. Enjoyable and useful as the service of a trained nurse is in an individual case of sickness, her services to the community are very much greater, by virtue of her theoretical and practical teaching. May I tell you what a good trained nurse may teach, and can teach? How to recognize a fever, how to compare the local temperatures of the several parts of the body, and how to equalize them; she knows that ever so many feeble children might have been saved, if but the feet and legs had not been allowed to get cold; how to bathe, when, and when to stop; how to regulate the position of the head—I remember quite well the case of inflammatory delirium which would always be relieved by propping up the head—how to treat intelligently an attack of fainting; how to render cow's milk digestible by repeated boiling, or lime-water, or table-salt, or farinaceous admixtures; how to feed in case of diarrhœa; how to refuse food in case of vomiting; how to apply and when to remove cold to the head; how to ventilate a room without draught; and a thousand other things. She will also use her knowledge and influence in weaning the public of nostrums, concerning which hardly anything is known except what you have to pay for the promises of the label. She will break the public of the indiscriminate use of quinia, with its dangers possibly for life; cure you of the tendency of making the diagnosis of malaria the scapegoat of every unfinished or impossible diagnosis; she will teach you that the frequent and reckless domestic use of chlorate of potassium leads to many a case of ailment, to chronic poisoning, possibly in the shape of Bright's disease or to acute poisoning with unavoidable death. These are but very few of the things she can do, and but a little of the knowledge she can not but distribute. With the aid of the class of women who frequent our training-schools, the public at large must and will gain, in a short time. Let the number of the schools increase, and increase the number of pupils, and every one of them will be a teacher and an apostle of sound information on sanitary and hygienic subjects. And let nobody leave this place to-night without intending to aid an institution as helpful as this.

Will the pupils come? Certainly they will. There is an increasing demand for their services. Many times had I to wait a day or two before any of the schools could accommodate me. There is no fear that there ever will be too many good nurses. There is fear, either, that many persons of inferior intelligence and morals will present themselves for or obtain admission to a school. By attending the suffering, it is true, many a crude or brutal nature is ennobled; but I should not advise to run the risk of admitting that class at the expense of the sick, or of a rising and beneficent profession. The occasional specimens of

cold-hearted and arrogant persons one is apt to meet, even among trained nurses, must discourage the admission of any but the very best. These *will* apply. The calling is an honorable one, it promises a competence, it corresponds with the innermost nature of woman. It is not true that the Church alone could raise the enthusiasm for hard work, the performance of arduous duties, and self-sacrifice. One of the first nurses I had in my division in Bellevue Hospital, many years ago, was an accomplished girl, the daughter of a rich man in the far West. After a year and a half it took all the influence and begging of her family to take her away from us and her hard work among the poorest of the poor. The large number of ladies, wealthy and accomplished, who work assiduously and regularly under Felix Adler, and in other places, under our very eyes, prove that the very best class of society can be prevailed upon to do the hardest and most beneficent kind of work. And the fact that the *élite* of the women of the city are willing and anxious to undertake the arduous task of founding and supporting training-schools, in the face of all sorts of difficulties, proves also that the work is in accordance with the requirements of both woman's nature and humanity. There will be many trained nurses who will work for humanity's sake, as centuries ago they claimed to serve for God's sake. Many a woman who would have buried herself in a monastery centuries ago, driven from the face of the living earth by misunderstood and unsatisfied longing, I believe, would nowadays become a nurse, knowing and enthusiastic.

Ladies of the graduating class: The remarks I was expected to make have extended into a lecture. You have been used to lectures, however; if you had not enjoyed them, and profited by them, you would not be here to-night, the most honored and most conspicuous of this assembly. Thus I thought I might be permitted to speak, instead of to you, of you, and your chosen calling and its history. From nothing can any profession derive so much advantage as from the history of its development. It is certainly an interesting spectacle to see how your profession depended intimately on the changing conditions of thought and feeling among mankind. You are happy enough to live and work in a time when, while following individual tastes and having individual motives, your labors are given to the suffering for no outside reason, no church command, but from the free choice of free women in the interest of humanity. I had also to allude to several subjects which may to some appear a little outside the legitimate domain of your ambition and duties. You know better. An intelligent woman will not spend two of her young years in acquiring a certain knowledge without enlarging her horizon in general. You have chosen a profession as noble and as deserving as any there is in existence. You will be the interpreters and right hands of the physician, and the connecting link between the physician and not only the single patient, but also the public at large. My opinion

of the services you can render is high, but I trust not exaggerated. When your numbers shall increase, and the character of those who are admitted remain of the same standard, your importance will grow. In your hands will, to a great extent, lie the opportunity for removing prejudices, spreading knowledge, healing and preventing disease. Even those of you who will not always consent to serve in *other* people's homes, will, by example and by teaching, remain in close alliance and co-operation with such as intend to remain in the ranks forever. As you now mean to leave us, endowed with the certificate of the required accomplishments, I can only add, while offering my best wishes for your future, that I trust you will never forget the place which gave you so ample opportunities for perfecting yourselves. You will never forget the gentlemen who taught you, nor that accomplished young woman who impressed all of you with the fact that the charms of womanhood will not suffer from hard work, from a classical education, and thorough medical or other knowledge. Do not forget, also, at the beginning of your independent career, the ladies to whose care and sacrifices and labors you owe the existence of the school which sends you forth as its first graduates, nor the great charitable institution which, after having given you your practical training, honors you to-night by the presence of many of its officers, and designates its president to deliver to you your diplomas.

CLOTHING AND THE ATMOSPHERE.

By M. R. RADAU.

CLOTHING is a kind of armor to help us in the battle against the elements, the importance of which increases with the rigor of the climate which man inhabits. The house may be regarded as an amplified clothing, to be used less constantly, but as more enduring than other clothing, and capable besides of furnishing a full shelter. Both clothing and the house have been invented to protect us; but a very common error, which has given rise to many mistakes, has been to regard the house and the clothing as designed essentially to isolate us from the external air. The truth is, that they are simply regulators of our indispensable and constant relations with the ambient atmosphere. These relations can not well be comprehended unless we take account of the complex phenomena by which the temperature of the body is kept up in the midst of the most diverse influences. We know that animal heat is produced by chemical changes that are accomplished in the tissues, and principally, but not exclusively, by the combustion of the food which is assimilated and brought into the circulation, where the inspired oxygen transforms it into alcohol and carbonic

acid. This combustion raises the temperature of the blood, and the warm liquid, which penetrates everywhere, warms the organism almost in the same way that a house is heated by hot-water pipes. The activity of respiration and the consumption of oxygen are diminished during sleep, but increased in taking exercise, when a part of the heat produced is transformed into mechanical work; but, from birth to death, man continues, without ever wholly resting, to draw the breath that keeps up the fire of life.

Notwithstanding this incessant production of heat, which may be increased or diminished, according to circumstances, by as much as fifty per cent, the temperature of the body continues almost invariable. In health it is always about 98°, and seldom varies as much as 2°; and yet we know that in some regions of the globe the monthly means of external temperature present variations rising to more than 115°, with much wider divergences in extreme cases. In parts of Siberia the extremes range from 70° or 80° below zero to 80° or 90° above; temperatures of from 120° to 130° have been remarked in hot regions in Australia and Asia; and men have been able to support much higher temperatures than these for a short time — Blagden 259° for seven minutes, and a certain Martinez, by wrapping his head in cloth, 338° for a quarter of an hour. Under such excessive heats, the temperature of the blood may rise a few degrees higher than its ordinary extreme; but such cases are abnormal.

Constancy of bodily temperature is an indispensable condition of health to warm-blooded animals. By what means does Nature supply deficiencies of internal heat and eliminate an injurious excess, and, in either case, restore the organs to the temperature which is most agreeable to the regular performance of the functions of life? The means are various. When food becomes insufficient, calorification is effected at the expense of the tissues of the animal, and it grows lean. When heat is produced in excess, the organism rids itself of it speedily by several outlets. The body may be cooled by radiation, by evaporation, or by conduction or convection. It is estimated that radiation generally carries off half, and the other two ways a quarter each, of the surplus heat. These ratios are, however, far from being constant; they vary with external circumstances. Evaporation is the valve that regulates the loss of heat, by completing, at a given point, the action of conduction and radiation.

The intensity of radiation, by which heat is dissipated from the body around, is proportional to the difference between the normal temperature of the body and that of the surrounding medium, and increases in the neighborhood of a very cold body. We may in this way explain the chilly sensation we feel and which persists in a room that has not been used for a long time, after the fire has been kindled, and even after the air in the room has become quite warm; while, after the room has been well warmed up, we may feel quite comfort-

able in it, even with the air at a lower temperature than that in which we were previously chilly. In the former case the walls and the furniture were still cold and abstracted so much caloric as to provoke radiation from the body. The loss of heat becomes less and the sensation of cold disappears as soon as the objects around have become tolerably warm. This also explains why it is dangerous in winter to stay long near a wall or a window where one side of the body is exposed to be cooled by excessive radiation.

For a similar reason we feel too hot in a room full of people, even when the air is only moderately warm. The presence of a considerable number of persons prevents radiation, and the excess of heat can be carried off only by currents of air, or by a more abundant transpiration. We fan ourselves to expedite the cooling by convection and evaporation, by bringing more air in contact with the skin; and if we leave the room when we are nearly smothered, to go out "to take a breath" in an empty room, we shall be astonished to find by the thermometer that the temperature of the two rooms is nearly the same; only that radiation is free in the empty one. The agreeable refreshment the shadow of the woods gives us is due to the relatively low temperature produced in the trees by their faculty of evaporation, and the facility it affords for promoting radiation from the skin. The body is also cooled by convection, or by giving off its heat to the air that bathes it, and this loss is more sensible in proportion as the air is cooler and more frequently renewed. The atmosphere is always in motion, even when apparently most calm; and thousands of its movements escape our senses, because they are not strong enough to impress our organs. These ceaseless motions, it must be clear, contribute greatly to the cooling of our bodies; but the effect is most marked in the open air, when we are exposed to the action of the winds. In our climate, the average velocity of the atmospheric currents is about ten feet a second, or seven miles an hour. Supposing that the extent of the surface of the body exposed to the currents is one square metre, there pass over a man walking out for an hour about eleven thousand cubic metres of fresh air. In hot climates we seek the shade, not only because the air under it is fresher, but also because it has more motion, in consequence of the differences in density arising from the unequal heating. Notwithstanding all the devices that have been contrived for the reduction of temperatures, it is evident that civilization is possessed of more varied and efficacious means of contending against the cold than of mitigating the effects of the heat. It is for this reason that the European finds it so difficult to acclimate himself under the tropics. The Hindoo reduces his internal calorification by eating little; but he is at the same time defective in energy, and has extremely little capacity to work. Assiduous labor exacts a large quantity of food, while an excess of surplus heat simultaneously results from it; for the organism can convert into mechanical labor only about twenty-five

per cent of the increase of heat which it produces under a sustained effort. The problem we have to solve is not to seek for a way of producing less heat, but to find a means of getting rid of that which we do produce.

Water is a much more effective refrigerant than air, because of its much greater conductibility; at the same temperature, a bath of water will refresh one more than a bath of air; but baths are necessarily of limited use. The important matter should be to diminish the temperature of the air that comes in contact with the body.

We have next to consider the effect of evaporation through the lungs and the skin. When the thermometer indicates more than 98° in the shade, the body can no longer be cooled by contact or by radiation, and only a single way is left by which the surplus heat can be dissipated. It can only expend itself in vaporizing the water which transpiration carries to the skin and to the mucous membrane of the respiratory apparatus. The lungs, as a rule, exhale about half as much water as is excreted by the skin. Both together remove about a kilogramme of water every twenty-four hours, disposing of as much heat as would boil five quarts of water; but the quantity of water and of heat removed in this way may be doubled and even tripled when all the channels of transpiration are fully opened under the pressure of an excess of internal heat. The vapor disengaged by these operations is absorbed by the surrounding air with a facility proportioned to the dryness of the atmosphere, or to the degree in which it is removed from the point of saturation. There is a limit at every degree of temperature to the proportion of vapor which the air can contain; and the interval between the points of dryness and of saturation increases with the temperature. An atmosphere at the same time very moist and very hot seems heavy to us because it hinders the evaporation of the water that transpiration brings to the surface of the body. This is why hot and moist climates are so much more unhealthy than hot and dry ones.

When the internal calorification is increased in consequence of violent exercise, the excess of sensible heat is eliminated by a more intense radiation, by ascending air-currents, and by a more abundant transpiration; it thus happens that after several hours of sustained effort we sometimes observe a slight cooling of the body, an effect which is the result of a too rapid using up of disposable materials. Hence, to cite the illustrations given of this fact by M. Bouchardat, dogs, which have run long at the hunt, and the overworked and exhausted children in the Belgian coal-mines, returning to the lodge or to their home, first of all things, before even satisfying their hunger, stretch themselves before the bright fire for warmth.

Thus the means of refrigeration at the disposal of Nature are quite varied; they complement and replace each other according to circumstances. But it is necessary to avoid the too abrupt changes which

would surprise the system while it is in the process of accommodation. "The organization," says Dr. Pettenkofer, "is a prudent and faithful servant, which will deliver itself and its master from trouble if it is given time to set itself right and is protected against rude treatment." The body, even when exposed stark naked to the air, is not wholly without defense against heat and cold. It can, up to a certain point, itself regulate the expenditure of caloric by the intervention of the vaso-motor nerves that go to the capillaries of the skin. Cold provokes a shrinking of the little vessels, and, restraining the peripheric circulation, diminishes the radiation and the transpiration to such a degree as to protect the internal organs for a considerable time. Heat, on the other hand, dilates the vessels so that the blood flows to the surface and the caloric is in a certain way driven out. Unfortunately, this automatic regulator, the play of which is commanded by the nerves, is too easily disordered and its springs are too easily relaxed. We can doubtless fortify it by exercise, harden ourselves, and habituate the body to support inclement conditions; and there are peoples and persons who have done wonders in this direction; but the hardening process works under limitations, and its results are not within everybody's reach. The real regulators of the heat of the body are clothes.

The thinnest veil is a vestment in the sense that it moderates the loss of heat which radiation causes the naked body to experience. In the same way a cloudy sky protects the earth against too great cooling in spring nights. In covering ourselves with multiple envelopes of which we augment the protecting thickness according to the rigor of the seasons, we retard the radiation from the body by causing it to pass through a series of stages, or by providing relays. The linen, the ordinary dress, and the cloak constitute for us so many artificial epidermises. The heat that leaves the skin goes to warm these superposed envelopes; it passes through them the more slowly in proportion as they are poorer conductors; reaching the surface, it escapes, but without making us feel the chills which direct contact with the atmosphere occasions, for our clothes catch the cold for us. The hairs and the feathers of animals perform the same function as toward their skin, serving to remove the seat of calorific exchange away from the body. The protection we owe to our clothes is made more effectual by their always being wadded with a stratum of warm air. Each one of us thus has his own atmosphere, which goes with him everywhere, and is renewed without being cooled. The animal also finds under its fur an additional protection in the bed of air that fills the spaces between the hairs; and it is on account of the air they inclose that porous substances, furs, and feathers keep warm.

Experiments to determine the degree of facility with which different substances used for clothing allow heat to escape were made by Count Rumford, Senebier, Boeckmann, James Starck, and M. Coulier.

The results were not in all cases consistent with each other, but they indicate that the property is dependent on the texture of the substance rather than on the kind of material, or—as concerns non-luminous heat—its color.

The most recent experiments are those of Dr. Krieger, some results of which are cited by Dr. Pettenkofer. He observed the rate of cooling of a sheet-iron cylinder filled with hot water and covered by turns with different cloths. Wrapping it with successive envelopes of wool, buckskin, silk, cotton, and linen, and observing regularly the diminution of temperature in a given time, he found the differences insignificant, not exceeding one or two per cent. The color of the materials did not cause the results to vary any more. It appears, then, that in a dark heat the emissive power and the absorbing power, which is correlative with it, vary but little between one kind of cloth and another. The case is different when we have to do with luminous heat, or the solar rays. With envelopes of linen, cotton, flannel, and silk, M. Krieger observed that the absorption of solar heat increased in the proportions indicated by the numbers 90, 100, 102, and 108. The influence of color was much greater: with cotton goods of different hues he found the numbers to be—white, 100; straw-color, 102; yellow, 140; bright green, 155; dark green, 168; Turkey red, 165; bright blue, 198; black, 208. These facts explain why in the hot sun a black coat is warmer than a white one, while the difference disappears in the shade. The influence of colors on the absorbing powers of surfaces had already been made clear by the researches of Leslie and Melloni.

To form an estimate of the part which the conductibility proper of the different materials plays in these phenomena, M. Krieger inquired how much the loss of caloric was diminished when the cylinder was covered with double layers of the same cloths. The doubling of the satin, cotton cloth, and fine linen diminished the loss only by from three to six per cent, while doubling the envelopes of buckskin, flannel, and woolen cloth diminished it by ten, twenty, and even thirty per cent. It is clear from these experiments that the resistance offered by cloths to the passage of heat depends much less on the conductibility of the fibers that form their substance than on the thickness, the volume, and the texture of the tissues. This can also be shown in observing the cooling of a cylinder covered with wadding, which is forty per cent more rapid when the wadding is strongly compresesd. So a dressing-gown lined with wadding and a flannel waistcoat are warmer when we first put them on than after they have been worn for some time. The packing which the filaments undergo with use renders the cloth more permeable to heat. Although doubling the envelope has little influence when both layers are stretched tight over the cylinder, it is not the same when a slight space is left between them; then the cooling is retarded thirty or thirty-five per cent by

the interposed stratum of air. Hence, we should expect in many cases to find a loose garment warmer than a tight one; and we know that close-fitting gloves or shoes afford but a poor protection against the cold. This reasoning, however, supposes that the protecting layer of air is motionless; but more frequently an ample and flowing garment favors the circulation of air, and therefore seems to us to be cooler, and is for that reason preferred in summer and in hot climates.

We are now brought to the important fact that the most serious obstacle to the propagation of heat in any body is the discontinuity of its elements. This is because heat is a mode of motion, and every derangement of molecular continuity impedes the transmission of vibrations. This principle is more or less unwittingly put to profitable use in the manufacture of clothing. We obtain very warm clothes from light, loose, and porous tissues, having a capacity to retain in the spaces between their fibers a large volume of air. I said, retain; I might more properly have said, let pass; for the air which our clothes inclose is not motionless, but circulates and undergoes constant renewal in filtering through the envelopes which we mistakenly believe are intended to isolate us from the surrounding medium. It is, in fact, an essential condition of a good garment that it shall not interpose an obstacle to ventilation. The warmest clothes let the air pass more readily than those which are considered cool. Dr. Pettenkofer demonstrated this fact by measuring the volumes of air which under the same pressure and in the same time passed through a series of tubes stopped by pieces of different kinds of cloth. The numbers representing the volumes were for the different goods: flannel, 100; linen, 58; silk, 40; strong cloth, 58; buckskin, 51; glazed skin, 1. Flannel is, then, a hundred times more permeable to the air than a glazed glove, and we know at the same time that it is infinitely warmer. The volumes of air transmitted are but little changed by doubling the goods. Our clothes are thus continually aërated by an exchange, the activity of which depends on the external temperature, the degree to which the atmosphere is agitated, and the porosity of the tissues; the essential point is that the change shall be so slow that the nerves of touch shall not be affected by it. The warmest coat is one of fur, and its warmth lies not in the skin only, but chiefly in the hairs, although their mass is relatively insignificant, and is almost wholly due to the air interposed between them. Furs are warmer in proportion as the hairs are finer, because, doubtless, the air that circulates through them is more thoroughly warmed. There are formed around the bodies of furred animals superimposed strata of air, the temperature of which diminishes from the skin to the ends of the hairs; and in winter the animals seem cold to the touch, while the zone of exchanges retires toward the skin as the cold becomes more intense. The body of the animal is, then, cooled principally by convection and by the ventilation which incessantly removes the heated

air. When the atmosphere is much agitated the cold penetrates more readily through the furs, and also through our overcoats, as all know who have been much exposed to cold winds. According to M. Krieger's experiments, the loss of heat through the skin is doubled when the fur is shaved off, and tripled when the skin is varnished. These facts bring us to the conclusion that the goods called impermeable are generally anti-hygienic, because they impede the aëration of the garments beneath them. They are good for protection against rain, but they excite perspiration and prevent its evaporation, and are very uncomfortable in pleasant weather.

Another very important property in cloths is their hygroscopicity; they condense moisture from the atmosphere and become impregnated with it the more speedily as the air is more nearly saturated with vapor, and consequently less capable of favoring evaporation. The condensation, which is equivalent to a kind of dew, is increased when the temperature is diminishing. According to M. Coulier's researches, the water absorbed by a cloth may be divided into two parts: one part which is not perceptible to the touch and can not be pressed out —the hygrometric water proper; and the other part, that which fills the pores and can be wrung out, and which M. Coulier calls interposed water. According to his experiments, wool is more hygroscopic than hempen cloth, and linen than cotton. Dr. Pettenkofer compared the hygroscopic qualities of a piece of linen and a piece of flannel having equal surfaces and nearly equal weights. Having been previously dried at the boiling-point of water, the two pieces of goods were exposed together in places more or less moist, and the variations in weight they went through after several hours of exposure were measured. It was found that wool was nearly twice as hygroscopic as linen. Similar differences between different materials may be observed when they are wet by immersion. Linen gets wet much more speedily than wool, but the wool really absorbs the most water.

The quantity of water that cloths are capable of absorbing is evidently more considerable than is commonly supposed. A woolen coat weighing five or six kilogrammes may take up nearly a litre of water, and this will add a kilogramme to its weight. We see also that cloths absorb more moisture when the temperature is low than at ordinary summer heat. Wet garments conduct heat better than dry ones, and consequently give much less protection against chills; hence the danger of cold combined with dampness. But wool, although it is more hygroscopic than linen, protects better against the effects of humidity because of the slowness with which it absorbs and gives off water, and because of its indestructible porosity.

As we fill up the meshes and pores of a tissue, it becomes less permeable to air, and goods with close meshes, like linen, cottons, and silks, feel this effect much more quickly than woolen goods. As Dr. Pettenkofer remarks, the elasticity of the fibers counts for much in

the persistence of porosity. The fibers of wool, even when moistened, lose but little of their elasticity and do not allow the pores to close, while the filaments of linen, cotton, and silk become quite soft under the influence of moisture, and do not resist the invasion of the water. For this reason damp wool cools us much less than damp linen. A linen or silken shirt is cooler than a woolen one, because it more completely sponges off the sweat and exposes it to evaporation. These facts illustrate clearly the capital influence which space between the fibers exercises on the physical properties of cloths. A cloth must evidently be considered as a tissue formed of textile matter and air. The properties of the fibers themselves can give us only the most incomplete ideas of the physical effects which their assemblage would bring about. The arrangement of the fibers and the manner in which they are prepared are most frequently the important points. There is reason to believe that by looking along this road, still so little explored, we shall reach results that will permit us to make a better use of some of the innumerable textile materials which Nature has put at the disposition of our industry.

Hygienists, in speaking of different cloths, are generally contented with classifying them vaguely in the order of conductibility, and of designating by that word the greater or less facility they offer to the passage of heat. It is agreed that conductibility decreases in the following order: linen or hemp cloth, cotton, silk, and wool. Cloths made of linen, hemp, and cotton, are considered the coolest. They are readily moistened and cool the skin by both conductibility and evaporation. Linen, whether made of hemp or flax, is, says M. Bouchardat, of all substances destined for clothing, the one that most favors the affections resulting from the impression of moisture on the skin. But with many persons the coolness and pleasant feeling of linen are very highly appreciated as advantages.

Cotton cloth lets less heat escape, absorbs and retains a part of the perspiration, and cools less rapidly by evaporation; its use is generally more advantageous than that of linen. An opinion or prejudice prevails widely that cotton is less healthful than linen, based on the fact that, being a less perfect conductor and rougher, cotton irritates the skin more than linen does. Examined with the microscope, the fibers of cotton appear angular and stiff, while those of linen are round and supple. Cotton is not agreeable in cutaneous affections, but wool, in such cases being more hairy and warmer, would be still more disagreeable. This is the only condition, says M. Bouchardat, in which any other substance than very fine, well-washed, and well-worn linen can be worse than it. Aside from this, cotton cloth has the advantage over linen of being warmer in winter, and, in summer, of not exposing the body to the dangers of too rapid cooling. It should be used in preference to linen by inhabitants of cold and moist countries. Wool is still more irritating than cotton, on account of the stiffness of the

hairs with which it bristles; but the excitation it produces becomes a therapeutic means whenever the skin needs a stimulant. Unfortunately, its use next to the skin may become the source of the infirmities for the cure of which it is indicated when too effeminate an education has caused us to contract the habit of wearing it too early and without sufficient reason. It may cause a grievous predisposition to colds, rheumatisms, and neuralgias, while, the habit once acquired, it can not be given up without danger. But the use of wool is precious in some countries and under some conditions of life.

Professor Brocchi, a writer well known for his investigations in malaria, attributes the good health and vigor of the ancient Romans to their habit of wearing coarse woolen clothes; when they began to disuse them, and to wear lighter goods and silks, they became less vigorous and less able to resist the morbid influence of bad air. It was first at about the time the women began to dress in notably fine tissues that the insalubrity of the Roman air began to be complained of. Dr. Balestra, in his book on the "Hygiene of the City of Rome and of the Campagna," admits that there may be some little truth in these views, although the increasing unhealthfulness of the Roman climate was chiefly explainable by the abandonment of cultivation and the physical degeneracy of the people in consequence of the general change in the manner of living. At any rate, woolen clothing has a right to be considered an excellent prophylactic in countries infected with malaria. "In the English army and navy," says Dr. Balestra, "the soldiers of garrisons in unhealthy places are obliged constantly to wear wool next to the skin, and to cover themselves with sufficient clothing, for protection against paludine fevers, dysentery, cholera, and other diseases." According to Pâtissier, similar measures have been found efficacious to guard the health of workmen employed on dikes, canals, and ditches, in marshy lands; while, previous to the employment of these precautions, mortality from fevers was considerable among them.

The hygienic properties of wool are due, first, to a slight roughness of the surface that excites the functions of the skin; and, secondly, to its porosity, which, as we have already explained, moderates the expenditure of caloric and prevents a too sudden cooling of the body. Dr. Balestra believes that flannel contributes to the elimination from the body of the paludine miasms, which have been absorbed by the pores, and also to rid it of the deposits that cause rheumatic affections. The hypothesis is confirmed by the singular connection that seems to exist in miasmatic regions between rheumatic and intermittent fevers. Furthermore, woolen goods arrest in their down a portion of the germs borne in by the air which thus reaches the skin filtered and purified; Dr. Balestra has proved by direct experiments in marshy regions that thick and hairy woolen garments have the filtering power that is here attributed to them. It is hardly necessary to

add that such clothing, to afford real protection, should be frequently washed. Cotton is next to wool in value, and is preferable to linen, because it gives a gentle excitation to the skin. Silk also has a warm feeling, and might be substituted for flannel in the winter; but it could hardly be worn next to the skin in summer, on account of the excessive heat it provokes. Dr. Balestra insists that it is best for inhabitants of unhealthy countries never to go out without being provided with a woolen cloak or blanket, to be used in case the weather should change. The ancient Romans wore ample over-garments over their tunics, and never put them away. It is no less important to be well covered during the night; and precautions of this kind should be recommended to all who live in a swampy country. We are sometimes astonished when we see the natives of particularly warm countries enveloped in woolen, as the Arab in his burnoose, or the Spanish peasant in his tobacco-colored cloak. Such materials protect both against the rays of the sun and against the coolness of the night, and are excellent regulators of heat. It is dangerously imprudent to travel in southern countries without provision of warm clothing.

The hat completes the dress, as the roof crowns the house. It preserves the head from insolation and cold, and protects it against accidents. Without going so far as M. Bouchardat, who says that the best head-dress is none, we content ourselves with remarking that the hat should be light and well aired. According to M. Troupeau's experiments, conical and rounded head-coverings are cooler than flat ones, and preferable in hot countries.

The bed is not only a piece of furniture indispensable to secure repose; it is also, in fact, a dress for the night. Like other articles of clothing, it should be both warm and permeable to the air. The heat which the body gives off to the mattress and the coverings is continually taken away by the air that traverses them. "Beds designed to regulate the flow of heat," says Dr. Pettenkofer, "are with us thicker than the garments which clothe us during the day, for two reasons: first, because, the circulation being less active during rest and sleep, less heat is evolved; and, secondly, because the ascending currents cool us more rapidly in the horizontal than in the vertical position, where they rise from the feet to the head, passing over the whole body." The heat of the bed thus favors the peripheric circulation and assists the internal organs that have to keep up the calorification. To do without a bed for several days in succession is a great privation, not only because it deprives the limbs of rest, but also because of the troubles to the economy it induces. A too hot and too soft bed is also objectionable because it keeps the body in a condition of moisture that enfeebles the muscular system and reduces all the functions. Feather-beds are generally more noxious than useful. They are warm on account of the air they hold; but an air-mattress should be as warm. Birds also clothe themselves in heat when they sleep, by ruf-

fling up their feathers, putting themselves in the shape of a ball, and surrounding themselves with the thick strata of air included within the filaments of their plumage. We purpose in another article to consider the relations of our habitations to the atmosphere.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE SAVINGS OF SCIENCE.*

By P. L. SIMMONDS.

IN the last quarter of a century, very important progress has been made in our home industries and foreign commerce; but certainly the success that has been effected in the utilizing of waste products, and developing neglected ones, is not the least remarkable of recent scientific advances.

It is evident that, when considered from the point of view of industrial science, the phrase, "utilization of waste," may be fairly applied not only to the unused residual products of manufactures, but to the boundless, undeveloped wealth of nature. The beautiful aniline dye, produced from the tar of the gas-works, is not more an example of the utilization of waste than beet-root sugar, obtained from what, a century ago, was a weed growing by the sea-side. Nature produces, abundantly and spontaneously, in many countries, vegetable substances (such, for instance, as the esparto-grass), which were long allowed to run to waste. Important industrial uses have been found for many of them, and fortunes realized by numbers who have turned their attention toward rendering them articles of commerce.

The flesh of domestic animals fit for food is almost a waste substance in many countries, since it can not be locally consumed nor profitably preserved. In the River Plate republics alone there are 80,000,000 sheep and 25,000,000 cattle to a population of 2,500,000. For years sheep were only valued there for their wool, and, when flayed, carcasses were left to rot, or, when dried in the sun, piled up in stacks for fuel, while later on they were boiled down for their tallow. Sheep get very fat in the province of Buenos Ayres, and those of three and four years will give frequently from eighteen to twenty-five pounds of tallow. Countless numbers of sheep are boiled down every year in the so-called *graserías* only for the tallow, which forms one of the staple articles of export. The mutton is thrown away, or used in a dry state as fuel.

In the five years ending with 1850, more than 1,500,000 sheep and 200,000 horned cattle were boiled down simply for their tallow, in the colonies of New South Wales and Victoria.

* From a paper read before the London Society of Arts

We English are great meat-eaters, and, as our home supply is quite insufficient, we have to import more than 600,000 tons every year. With the growth of our population, and the decreasing number of live-stock at home, the imports of meat from abroad have prodigiously increased in the last quarter of a century.

In a paper read before the Royal Colonial Institute, Sir Francis Bell, the Agent-General for New Zealand, stated that frozen meat in any quantity can be placed upon this market from the other side of the world at 6*d.* to 6½*d.* a pound, leaving a good profit to the grower. "This," he added, "ought ultimately to make meat cheaper here, or at least prevent the further rise now threatened. Australia and New Zealand can, in fact, export 700,000 tons of meat a year, or 2,000 tons a day, which is not much more than you want in England even now, without reducing even the present capital number of their sheep and cattle, and we are able to send on sheep to Smithfield with greater ease to-day than the Tweed farmers could one hundred years ago, when meat was selling at a penny a pound in Scotland against tenpence in London."

Horses, although numerous in some countries, as in Russia and the River Plate states, have not been, commercially, very useful when dead. In South America mares are never broken to the saddle, and the carcasses are generally boiled down for their fat, the exports of mares' grease being considerable, while the hide is also useful. But, within the period now under our notice, horse-flesh has come largely into use on the Continent for human food. Its sale has become a legalized and recognized trade in many of the Continental states, especially in France and Germany. The published statistics of the Society for Promoting the Use of Horse-flesh show that, since its foundation in July, 1866, 160,080 horses, 6,690 donkeys, and 395 mules had been sold in Paris alone for food, up to the end of 1881, furnishing 67,809,460 pounds of meat. Horse-flesh is sold at half the price of beef. The innovation has gained ground rapidly in most of the principal towns of France, and the public sale of horse-flesh for human food is now general in Austria, Prussia, Bohemia, Saxony, Hanover, Switzerland, Belgium, and Sweden. In England, the hundreds of horses which die in the metropolis are sent, with other carcasses, to special firms, which utilize every part commercially. The skin is removed, and the bones are taken out with great expedition; the flesh is then placed in caldrons, of a capacity of 600 gallons. Upon boiling the flesh, the oil is separated, and used by soap-makers and leather-dressers. The bones are also boiled, yielding further oil and fat, and are afterward utilized for manure.

In the United States there was formerly a plethora of waste. The time was when, in Cincinnati, Chicago, and other slaughtering centers, the food of millions was cast out and allowed to be entirely lost by being thrown into the river, or burned in large pits. Now, such is

not the case, for the poor but industrious German and Irish populations have saved much of this extravagant waste, and, by their cheaper labor, almost the whole of these substances has been converted to profitable use. Even now a great deal of the ox is disused, which in Europe is esteemed most nutritious food.

There is an important industry which has sprung up out of animal waste, in the utilization of purified tallow and other fats for food and domestic purposes. It was originated in France in 1869 by M. Mége, and was intended for the manufacture of artificial butter from fat, by extracting the oil at a low temperature, and converting this, by churning, into butter. It was first known as oleomargarine, then as margarine, and latterly as butterine. The manufacture of this product has spread extensively, and it is carried on in the United States on a very large scale. As a London trade journal observed, a few weeks ago, "It is to be regretted that shopkeepers do not see their way to offer it to the public under its proper name, a proceeding which would be not only more honest, but which would ultimately tend to the more general adoption of butterine as an article of daily consumption."

From statistics prepared by Mr. Nimmo, of the United States Department of Agriculture, it appears that more than one third of the American exports of butter are sworn to be oleomargarine. Now, as we receive over 8,700 tons of so-called butter from North America, it is not pleasant to know that one third of this is the artificial butterine. Not only is margarine thus used, but, under the name of sueine, much lard is now introduced into the butter.

In the utilizing of inferior or waste materials, and in the separating of tallow from the substances with which it is found in combination, machines are employed which are both ingenious and effective, and by their use much material that would otherwise be worse than useless is turned to good account.

In Europe, rabbits are not a waste substance, but are eagerly sought for as food, and even bred in large numbers; but their introduction into Australia and New Zealand has proved an unmitigated evil to the colonists. About twenty years ago there was not a single rabbit in Australia, save, perhaps, a few domesticated pets. Since their introduction they have become a perfect pest, and the difficulty is to exterminate and keep them down by poison, dogs, etc.

From New Zealand alone 8,500,000 rabbit-skins were exported in 1880, but this does not probably represent one tenth part of the animals actually destroyed. In that climate the rabbit breeds nearly every month in the year. But even supposing that a pair of rabbits do not breed oftener than in England, which is seven times a year, and that they only bring eight young at a time, they would multiply in the course of four years to 1,250,000. Besides the skins shipped to England and America, the colonists are trying to send us rabbits' flesh in tins. Rabbit-skins are in demand by the furrier. About 30,000,000

indigenous rabbit-skins and 2,000,000 or 3,000,000 hare-skins are used up in this country. The skins of those which are not used or dyed as furs are, after the hair has been pulled for the hat-maker and for stuffing beds, employed for glove-making. The hair is also now used for making yarn and cloth.

The wool manufacture, in almost all countries, now uses up cuttings of cloth and shreds of all kinds which were formerly thrown away. These, and the strippings and waste in carding, are now classed immediately after pure wool, and command relatively high prices. There are many who may be disposed to regard the shoddy manufacture as a business to be despised, but the political economist discovers in it a most important source of wealth—wealth resulting from the application of skilled labor to the utilization of material once worthless, but now contributing no mean sums annually to the wealth of nations.

There are now 137 shoddy-factories, principally situated in the Yorkshire district, which employ over 5,000 persons, 3,000 of whom are females. About 40,000 tons of woolen rags are annually torn into shoddy in England alone, and the quantity made in the United States must be almost equal. No accurate data can be found of the European use of these articles, but an immense quantity of both shoddy and mungo is now made and exported from the Continent, principally to England, and it is probable that the whole of the world's annual consumption is over £7,000,000 in value. At the recent International Wool Exhibition, held at the Crystal Palace under my charge, there were shoddies sent from most of the states of Europe. Italy first began to work woolen rags into yarn in 1858, and most of the other European countries followed the example.

Raw silk having become scarce and dear of late years, much more attention has been given to the employment of the different sorts of silk waste, for which, at one time, scarcely any use could be found.

The variety of these is very large, and most of them are now profitably and extensively employed. The outside and inside husks of the cocoons used to be mere refuse. These pass under various trade names in different countries; in England, as "knubs and husks" and "floss silk"; on the Continent, as *bourre de soie*, *frisonets*, and *floret*. What is termed "yarn waste" is the waste made by the silk throwster. The pierced cocoons, that have been eaten through by the moths, are now largely employed in the preparation of *chappe*, or *schappe*. Then there are the noils and thread waste from the silk-factories.

In 1857 the imports of these waste silks were only 18,000 hundredweight, valued at £302,286. In 1881 the imports reached 540,119 hundred-weight, valued at £757,796. France, Switzerland, Germany, Great Britain, and the United States have now entered extensively into the utilization of silk waste for manufactures, which was formerly

a drug in the market. In the Swiss report on the Paris Exhibition of 1867, it was stated that the annual production of floss-silk yarns then ranged in value from £400,000 to £600,000. In 1872 about 7,750,000 pounds of thread were made from waste silk in Europe. In the United States, 2,000 to 3,000 bales of waste silk are used up annually, valued at £200,000. Italy exports annually about 5,000,000 pounds of silk waste.

There are fifteen establishments in France, with 479,353 spindles, working up waste-silk; that is, the waste from the cocoon not reelable, the short pieces, etc. What remains over from this working is again used up by seven other factories, which, by means of further combing and carding, employ waste formerly only partially utilized or altogether lost to consumption.

In connection with this subject I may draw attention to the stimulus given to the collection of the cocoons of the wild silk-worm of India, known under the name of *Tusser*. These, which were formerly only used in the East for making a kind of drab or coffee-colored silk, have now been made to take dyes, and are profitably employed in the silk manufacture in England. The waste of the wild cocoons in China and Japan is made into felt for hats, and enters into the manufacture of paper.

The improvements in machinery for the preparation and spinning of silk-waste have made great strides of late, and whereas a few years ago one never heard of anything but "spun-silk" hosiery, handkerchiefs, or some other little article of similar make, the whole world now knows the *schappe* velvets of Crefeld, the "spun" ribbons of Basle, and the laces of Nottingham, while the king of silk-spinners—Lister, of Manningham—has even produced machine-twist of excellent quality from this unlikely material.

The refuse from the tanneries, now so profitably utilized, is of considerable importance; it consists of untanned dried pelt, or glue-pieces, fleshings, hair, lime deposit, and spent-tan. Glue-pieces or "scrolls," as they are termed, are sold to the paper-maker, and scores of tons for the manufacture of gelatine and portable soups. Ordinary size is made from the flesh refuse of the hide, and is extensively used by paper-hangers, cotton-spinners (to give firmness to the thread), and carpet manufacturers. The so-called cheap seal-skins are manufactured in the north of England from common plasterers' hair, or that obtained from the tan-pits. There has been made for many years, in Germany, printing-paper and cardboard of the waste bark from tanneries. The common papers receive about ten or fifteen per cent of this pulp; the boards for roofing from twenty to forty per cent. Artificial leather is also now extensively made from leather cuttings, pressed and rolled into sheets with some glutinous composition.

Latterly it has been found that leather-waste cuttings, etc., when steamed with certain waste liquors, produce a valuable material in the

shape of a new black, which is destined to have a variety of important uses, such as in the manufacture of printing-inks, dark pigments, covering substances, and notably for the manufacture of blacking. Bone-black, from which the latter is chiefly made, costs £9 per ton, and the supply is limited, while this new tannic black can be sold at one third of the price.

The blood from the slaughter-houses, which used to be wasted, is now collected in Europe, and utilized for manufacturing into blood-albumen, which sells at about 1*s.* a pound. The drainings and the clot go for manure.

Among the miscellaneous animal substances now utilized, we find many species of fish-skin tanned, such as the so-called porpoise-skin, (*Beluga catodon*). Alligators and crocodiles, and even snakes, are hunted for their skins, which are tanned, and provide a valuable article for making slippers, purses, pocket-books, cigar-cases, etc.

Let us now pass to vegetable substances, and I will first consider the paper manufacture. A recent estimate was published, which set down the paper-mills of the world at 4,000, producing 1,000,000 tons of paper, of which one half was used for printing.

It is now evident that the future of the paper industry will, in a large degree, depend upon the use of wood, which is already extensively employed. For the ordinary varieties of paper, ground wood is used; but, for the finer sorts, chemically prepared wood-fiber, or cellulose, is employed. The practical process for the preparation of cellulose was discovered in 1852, and numerous other processes or improvements have since been invented. It comes into commerce in two forms—wood-pulp in sheets or blocks, and ligneous meal or wood flour. In Central Russia, aspen-wood is most extensively employed; in Sweden and Finland, spruce and fir, which afford the longest fibers; in Germany, France, and Belgium, mixed woods. The pulp from beech and birch woods has too short a fiber.

About twenty years ago, some of the American paper manufacturers used the bamboo largely for making paper. This is no new application, for the Chinese have long employed it for a common description of paper. Good paper is now also made from esparto-grass.

A good deal of the jute sent from India to the United States consists of the dark root, or butt-ends of the fiber, which are cut off when the jute is pressed into bales. These are called "cuttings" in Calcutta, and with us, "rejections"; they now form a regularly quoted article of export to America, where they are employed in the fabrication of various shoddy-stuffs. In former years these cuttings were thrown away. Megass, the refuse stalk of the sugar-cane, makes excellent paper. The husks of oats, barley, rye, and rice, are also used alone, or combined with other materials. Straw-board, of late years, has been found to be a cheaper material than the old-fashioned "pasteboard," and it has come extensively into use in America for paper-boxes.

Straw has long been employed as a paper material, but it is often scarce and dear. It is even found profitable to buy up the bedding-litter from the metropolitan stables, and, after washing and disinfecting it, to sell it to the paper-mills.

Until a very recent period, the waste-paper of the Government offices of London was the perquisite of the messengers. But when it was found that the aggregate sales of this waste-paper reached the sum of £10,000 to £15,000 a year, it was thought time to look into this, and it was then handed over to the Stationery-office, and, in the last financial year, the sale of waste-paper reached £11,771. The United States Treasury sells yearly more than 600 tons of paper-pulp, resulting from the destruction by maceration of Government securities, bank-notes, etc.

In one large printing and publishing establishment in London, the waste-paper, in shavings and imperfect impressions, exceeds seventy-five tons a year. Even the newspaper-offices now economize and use up their spoiled impressions, or overplus papers, for printing their posters on.

It is only since 1860 that the extraction of the oil from cotton-seed has been carried on on a commercial scale; before that date vast quantities of the seed were allowed to accumulate and to rot on the cotton-plantations. It is an industrial fact of considerable interest and significance, that at the present time the seed is often more valuable to the planters for its oil and oil-cake than the cotton-fiber, for of the latter it contains only about one quarter of its weight.

In the process of refining, the residue of the crude oil is distilled, and, with care, produces a hard grease or stearine, which commands, when of good color, within 3*s.* or 4*s.* per hundred-weight the price of Petersburg tallow. The by-product is used for making artificial butter. Even the foots, or tarry residue, is useful as a paint ingredient.

It would be difficult to define the limits to which the indirect consumption of Indian corn extends. Every pound of American pork eaten, the laundry and food starches used, the large production of alcohol (that of whisky in the States is 67,000,000 gallons), the varnishes used by the cabinet-maker, the perfumery of the toilet-table, the different kinds of illuminating fluids, all indicate the universality of the employment of maize.

It was in 1867 that a new use was found for maize, by converting it into glucose. The report of the New York Chamber of Commerce states that the production of this sugar is now not less than 1,000 tons a day for the whole United States.

In America, they are also endeavoring to utilize the immense quantities of pulp remaining from the corn after the extraction of the starch. This pulp, which is at present a waste product, consists wholly of cellulose or woody fiber, and would, it is considered, be an

excellent material for making the commoner grades of paper, suitable for wrapping and newspaper purposes.

The present sources of the supply of potash are rapidly failing; every year the area of the supply becomes smaller, and the product, in consequence of this and the increased demand, becomes more and more expensive. The cobs of Indian corn, which are now considered of little or no value, may yet share the same fate as many substances which, though formerly considered worthless, have become new mines of wealth, through the aid of chemistry.

The average yield of 1,000 parts of cobs is 7·62 parts of carbonate of potash, or nearly twice as much as the best specimens of wood, and it is a material which can fill its full measure of usefulness for other purposes, before it comes into the hands of the manufacturer of potash. At the shipping ports, large shelling-mills are established, capable of running through 500 bushels of corn an hour. Here, then, are the places where a supply of cobs may be procured.

The corn-crop of North America varies; but, taking the yield of 1871—1,100,000,000 bushels, at fourteen pounds of cobs to the bushel—this would yield 7,700,000 tons of cobs, containing an average of three quarters per cent of pure carbonate of potash. The enormous quantity of 115,500,000 pounds of that useful article might thus be thrown into commerce. In some districts, these corn-cobs are extensively used as fire-lighters, being dipped into a composition of resin and tar, and then dried.

It is only some twenty years now since glycerine, a by-product in the manufacture of soap and candles, has been produced on a commercial scale, but the quantity now made represents an annual value of nearly a quarter of a million sterling. Glycerine has thus attained to a position of considerable technical importance. The introduction of the stearine-candle industry and the efforts to utilize the heretofore waste products of the soap manufacture demonstrated its existence in considerable quantity. The important uses to which this substance is now applied are so numerous that it would be difficult to enumerate them.

There is a large consumption of cork-bark, in this and other countries (the quantity we import exceeds in value half a million sterling), and even in this direction the economizing of the waste is found profitable and useful. The suberine powder is made into cork carpets for floor-cloth, and it is even used by chemists in place of lycopodium, powdered rice, starch, etc. Old corks are collected, and cleaned with hydrochloric acid and hot water, so as to be used again. The Paris sewers are provided with gratings, and the corks thus collected are re-cut, and used again. All cork cuttings are useful for filling life-buoys, belts, jackets, and even beds.

In Europe, as much use has not been made of sea-weed as in China and Japan, where it forms a very large article of consumption for food. In China, it is imported both from Japan and Asiatic Russia, to the

extent of more than 25,000 tons a year. It is received in two forms: first quality, cut, and some known as *agar-agar;* and second quality, long. This sea-weed is principally consumed by the lower classes of Chinese as a condiment or flavoring, with their rice or other food.

Another product into which sea-weed is converted is gelose—a sort of vegetable isinglass. Viewed from whatever direction, the more general utilization of sea-weed is a most important matter. In some of the northern countries of Europe, cattle are fed on it. Formerly, iodine was only obtained in any quantity from the kelp of sea-weed, but it now appears likely that it can be produced in Peru at a comparatively small cost, as a by-product extracted during the process of manufacturing nitrate of soda; while the necessary arrangements for the manufacture of iodine from kelp are very costly, and the works and machinery used require a large sum of money. It is possible that 5,000 or 6,000 hundred-weight of iodine might be manufactured in Peru at a low cost, but the war with Chili interfered materially with the production. With the exception of the manufacture of kelp, the principal use of sea-weed is for manuring land. Under the name of carrageen, or Irish moss, some is used for food. In France, a gelatine or gum is prepared from sea-weed, which is variously useful in the arts, as in finishing cotton fabrics, making artificial leather, etc. When chemically prepared and pressed, it was, at one time, used extensively for the manufacture of a substitute for horn, called laminite, but this has been dropped. It has occasionally been made into paper.

There is an application of waste substances of vegetable origin that is largely carried on, which certainly does not merit approval, being, for the most part, prosecuted for the purposes of deception and fraudulent gain, and this is in substitutes for, or additions to, coffee. Figs, date-stones, lupines, malt, chiccory, etc., are largely sold, besides the seeds of a stinking weed (*Cassia occidentalis*) which, when roasted, according to French authorities, is equal to coffee. While the production of coffee is fully equal to the demand, and the price is moderate, I can not see the necessity for these various substitutes. The more legitimate use of date-stones is that to which they are put by the Arabs. They are soaked in water for two or three days, and, when somewhat softened, used to feed their camels, cows, and sheep. There are shops in Medina where they sell only date-stones, and the poor often occupy themselves in collecting the date-stones thrown about the streets by those who eat dates.

Cocoa is not so largely consumed in this country as on the Continent. But the cocoa shells or husks which are separated from the nibs after sifting are imported here to the extent often of 500 tons annually, paying a duty of 2*s.* a hundred-weight, against 9*s.* 4*d.* a hundred-weight charged on cocoa and chocolate. These shells or husks form about twelve per cent of the weight of the beans. In the manufacture of the finer chocolates they are always separated, and hence accumulate

in large quantities in France and Spain. In the cheaper kinds of chocolate and cocoa, these husks are ground with the nibs, and some other cheap farinaceous substance is added. The black appearance of such chocolate is unmistakable; it will always be found gritty and rough, and, of course, difficult of digestion. The husks are no better than sawdust, and may cause irritation by the minute spiculæ left after grinding.

I must now touch upon the utilization of mineral waste.

The utilizing of tin-plate cuttings and the recovery of the tin have become important and profitable industries. In the manufacture of tin-ware, it is said six per cent of the whole of the plates employed disappears in the form of scrap. Birmingham produces thirty tons per week. Mr. Beck, of that town, is said to have made a profit for many years of £100 a week by taking off the tin from the scrap by solution and precipitation. A very fair trade is done by parties who go about the tin-works buying up the tin-dust. They even go to France and other countries, and ship it to England to be reduced. This so-called tin-dust is really the scum of the tin-pot, and, as it is mixed with grease, it is black. It contains a considerable quantity of metal, which is reduced by ignition and flux. An engineering paper states that the waste of tinned iron, used for all kinds of purposes, but especially for saucepans, kettles, button-making, etc., was formerly large, but a method is now employed by which the tin can be recovered from the waste, simply by the action of dilute sulphuric acid. Tin, to the extent of from five to fifteen per cent, and worth about £97 per ton, with a vast amount of sulphate of iron, is thus procured, giving a large profit on the operation.

Within the last quarter of a century, that formerly neglected mineral—pyrites—has been turned to useful purposes, to supply our manufacturers with the important material, sulphur.

In wire-making factories, the dilute sulphuric acid, formerly used to clean the wire, was allowed to run into the sewer, when it had become so charged with the iron scale as to cease to "bite," and large quantities of refuse wire were employed only to fill up hollows in grading, or thrown into a heap. All this waste material is now, however, converted into articles of commercial value. The processes are simple and comparatively inexpensive.

Not only in the inferior metals is waste now prevented, but increased attention is given to the collection of gold formerly lost. Immense heaps of refuse, or "tailings," as they are technically termed, accumulate where mining operations are carried on. The sludge which is emptied from the puddling-mills in Australia contains a considerable quantity of fine gold. Much of this is now recovered, and the yield of gold from it exceeds three pennyweights per ton. The right to wash the tailings is often sold to the Chinese, who are always well satisfied with the result of their labors.

The quantity of gold used in the arts, in interior and exterior decorations, in photography, electro-gilding, water-gilding, the ornamentation of china, etc., is very large, and the greater part is practically lost. Jewelers' sweepings from the floors of the workshops are carefully collected, and even the clothes of the workmen are generally saved and sent to the refiner. After a large gold coinage at the Royal Mint, there is always a great deficiency in waste and sweep. The sweep is composed of cinders or dust from the forge, the sweepings of the workshops, broken crucibles, the dross which adheres to the ingots of metal after fusion, and of every waste which can possibly contain minute particles of the metal. This is generally sold. The silver and gold from photographers' waste is also now carefully collected, and forms a considerable item of economy. A method of utilizing the waste of gold-leaf, used in printing and the arts, is by converting it into what is called fleece-gold. The composition is used like the ordinary bronze, except that rather more copal is mixed with it. It is used for all fancy papers for which gold-leaf and bronze have hitherto been used.

The waste of the glass-furnaces—such as pieces of broken glass, flaw-glass, the hearth-droppings, and the glass remaining adherent to the blower's pipe—is utilized again, serving a purpose in the manufacture of glass, similar to rags in paper-making. Agate glass is made by melting waste pieces of colored glass. One to two thousand tons of cullet, or broken glass, are collected in the metropolis alone, and sold to the few city glass-works to be remelted. Broken bottles are now collected and utilized. Thousands of tons of these are broken every year in London alone. Broken "wines" and broken "sodas" are converted to many useful purposes, the latter especially. The broken bottles are utilized for the manufacture of cheap jewelry, chimney-ornaments, and inferior household glass for the manufacturing districts. They are also used for the manufacture of emery-powder, glass paper, etc. Some idea of the number of "sodas" broken in the process of filling, corking, cleaning, and distributing may be gathered from the circumstance that one great mineral-water manufacturer in London sold last year one hundred tons. The value of the "metal," as it is styled, is somewhere about ten shillings per ton, but it varies according to the demand. When the market for "fancy goods" is active, broken bottles command a better price. A revival of trade sets this particular industry in motion along with others, and broken bottles are enhanced in value. In fact, broken glass and broken pottery serve many purposes, though it is only lately that economic science has learned how to turn them to account.

The utilization of blast-furnace slag is not new, but has made great progress. Scattered throughout the iron-making districts of Great Britain are many million tons of scoria or refuse from the blast-furnaces, which is technically known as "slag." This slag goes on accu-

mulating at the rate of nearly 8,000,000 tons per annum, its bulk being some three times that of the iron from which it has been separated. It forms a heavy incumbrance to iron-masters, demanding the purchase of large tracts of land whereupon to deposit it, while the investment is, of course, wholly unremunerative. There are one or two exceptions to this rule, where the slag is tipped into the sea, and serves to form land for the works, and where some of the iron-works supply slag for the construction of breakwater and training walls. The quantity thus utilized, however, on the Tees is but about 600,000 tons per annum, forming only a small proportion of the whole yield of the district.

In early times, slag was broken up by hand, and used for road-making, and it so continues to be used, where it can be had without a heavy cost for transport; but there is only a limited demand for this purpose. On the Continent, where stone is scarce, slag plays a prominent part in road-making, as in Silesia and other similarly situated districts. Another direction in which many attempts have been made to utilize slag, both at home and abroad, is to adapt it for constructive purposes, and various schemes have been devised for transforming the highly refractory slag into bricks, sand, and other materials for building.

It is also applied to the manufacture of artificial stone, and molded into chimney-pieces, window-heads, balustrading, and outside ornamental builders' work generally. The stone is composed of two and a half parts of finely pulverized slag, and two and a half parts of ground brick, to one part of Portland cement. The mixture is run into molds, and sets quickly, the articles being ready for the market in four or five days. Besides bricks and stone articles, the slag is used for making mortar, cement, and concrete. The mortar is a mixture of slag and common lime, the cement being composed of the same materials, with the addition of iron oxides.

Another useful purpose for which it has been successfully utilized is that of glass manufacture. The vitreous character of slag indicates a resemblance to glass in its composition. It does, in fact, contain the principal components of glass, but not in proper proportions, and those in which it is deficient have therefore to be added, with others which are not present. Bottles made of this slag by the Britten Patent Glass Company were shown at the Paris Exhibition in 1878, and received honorable mention.

Another application is to the manufacture of slag-wool. By the action of strong jets of steam, the slag is transformed into a fibrous whitish silicate cotton, which, being metallic, is incombustible, like asbestos. In the construction of new houses with Mansard-roofs, the space between the interior lath, or paneling, and the exterior covering of zinc, slate, or tin, is filled with this slag-wool, which protects from the rigor of frost in winter and the intense heat in summer. If in

winter the taps and spouts and water-pipes are covered with this slag-wool, it prevents the freezing of the water and the bursting of the pipes and joints. This slag-wool is also used now by gardeners to cover plants and protect them from the effects of sudden changes of temperature.

In view of the general usefulness of slag, when converted into the various articles described, it is to be hoped, in the interests of commerce and progress, that the practice of its utilization may become more and more extended. Doubtless, human progress will show that what is now the veriest waste will, in the course of time, assume a condition of value. Thus will art be made to approximate to nature, in that it will know no waste.

There are one or two other mineral substances, formerly neglected, which have of late years been applied to very extensive important uses. One of these is asbestos. This was long considered a mere curiosity for making small fire-proof articles. It is the only flexible fibrous mineral substance that is perfectly indestructible by fire or acids, notwithstanding it consists of fibers as fine as the finest linen. Now it is scarcely possible to enumerate all the uses to which it is applied. Among others are, as a roofing material, cement, paint, fire-proof coating for inside of factories, theatres, etc., in danger of ignition, felting for steam-pipes, boilers, lining for floors, roofs, etc.

A prominent and peculiar feature in the landscape of the coal-mining regions is the enormous heaps of black and apparently useless material collected near the outlet of each mine. As the quantity of small waste coal in the United Kingdom has been estimated at 28,000,000 tons per annum, the utilization of this refuse is a matter of national importance in more senses than one. It is now, in many districts, consolidated into blocks, and, besides what is used at home, 412,310 tons of this patent manufactured fuel were exported last year.

In several foreign countries, the pitch from coal-tar is combined with coal-dust, and pressed into the form of bricks, and an excellent fuel is thus produced, which, it is said, will generate a greater amount of heat than can be obtained from the same quantity of any other combustible material employed for utility or comfort, while, at the same time, it can be stored more compactly and in better shape than either wood or coal. Some 40,000,000 tons of valueless coal-dust, lying in the vicinity of the coal-mines and depots of Pennsylvania, have been thus gradually utilized. In some American factories they have found it cheaper and more advantageous to burn only coal-dust or pea-coal. A furnace or grate bar has been specially devised for the purpose of burning this kind of fuel, and there is no doubt, with its increasing uses, but that other convenient devices will be supplied for making it of more practical benefit. The utilization of this waste in the coal-regions of the United States is now a decided success. The American Fuel Company, Pennsylvania, works up large quantities of

culm (as the coal-dust is technically called) with pitch into blocks, brick-shaped, weighing but fourteen pounds each. Anything tending to the utilization of what is now waste is of value, when we consider that the amount of anthracite coal sent to market represents but about four fifths of the quantity that is actually raised from the earth, the balance being piled up in unsightly heaps.

Many of the subjects which I have incidentally touched upon have been so elaborately dealt with by specialists in papers before the members of this society, that the ground has been taken from under me, and I am but a gatherer and gleaner, summarizing, as it were, the results of their descriptions. Although, in the period under review, many of the waste products of manufactures, formerly thrown away, have been made to serve a useful purpose, there is yet room for fresh efforts in this direction, and the reward is certain. The manufacturer who discovers a heretofore unknown use for the waste product of his work necessarily cheapens the cost of the principal article of his production, and thus secures an advantage over competitors. Much, as we have seen, has already been done in this way, but there are many other products which could be made under the direction of that mighty converter, chemistry, to yield substances of use and profit.

Science has taught us how to transmute the waste and refuse materials—elements of pollution—into sources of economy and wealth. The utilization of the sewage of great cities for agricultural ends has virtually been a demonstrated success in Paris and many of our own towns. The same success, by patient experiment, is obtainable in many other waste products, which, in ignorance of their value, we suffer to defile our streets, pollute our rivers, and taint the air we breathe. The purification of the outflow of paper-mills and the utilization of the sludge and other waste products are now carried out.

It would have been impossible, in the limits of this paper, to refer in detail to more than a few of the principal examples of the successful use of refuse. But those enumerated will serve to show to how great an extent civilization is daily adding to the useful products of the world, both by economizing its resources and by calling forth new ones with the aid of chemistry.

SYMBIOSIS AND "VEGETATING ANIMALS."

A REVIEW.

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SINCE the publication of the interesting observations and speculations of Dr. Karl Brandt concerning the occurrence of chlorophyl in animals, of which a summary account was given in a recent number of this periodical, under the heading "A Partnership of Plant

and Animal Life," at least two important contributions to the same subject have made their appearance. One of these, written by Mr. P. Geddes, of Edinburgh, may be found in "Nature" of January 26, 1882. The other, from the pen of Professor E. Ray Lankester, was published in the April number of the "Quarterly Journal of Microscopical Science."

The spectroscopic examination of animal pigments, a line of investigation in which Professor Lankester was one of the earliest observers, has shed much light on these previously little known compounds, and has opened a wide field for further research. Especially fruitful in this direction was the announcement, perhaps a dozen years ago, that various animal greens yield a spectrum identical or nearly so with that furnished by chlorophyl, the common green coloring-matter of plants. At once a host of interesting questions sprang up as to the occurrence, structure, and properties of "animal chlorophyl"—all of which, however, culminated in this: Is the color "accidental" and unimportant in animals, or has it rather some profound significance, such as attaches to it when it is found in vegetable protoplasm?

It may well be considered as one of the fundamental truths of biology that chlorophyl in vegetable substance is no insignificant intruder. Though the exact method of its working is just now a matter of much dispute, the broad fact of its usefulness is freely admitted; in one way or in another, chlorophyl aids in the economy of the vegetable cell so that it feeds greedily upon the carbonic acid of the surrounding air or water, and tears to pieces, for building up afresh its own substance, compounds which, without chlorophyl, it would be powerless to utilize, or which if utilized would be speedily sacrificed. A long series of experiments, reaching from the time of Priestley to the present day, uphold and strengthen this fundamental fact; but, among them all, the simplest is the most unique and the most pronounced. If a piece of a green plant be immersed in water and exposed to sunlight, bubbles of oxygen are given off, and analysis will prove that carbonic acid has simultaneously disappeared from the water. With plants not green, or with animals, the facts are reversed—oxygen disappears and is replaced by carbonic acid.

The green plants, then, exhibit a peculiar power, viz., that of splitting up carbonic acid, and of availing themselves for the manufacture of starch, etc., of the carbon thus gained; at the same time procuring such a large supply of oxygen that they are able to reject a vast amount over and above their own needs. In this respect they differ from colorless plants and animals, and for this power they depend exclusively upon the agency of chlorophyl. We have no evidence whatever that the chlorophyl of plants has ordinarily any other function.

Very considerable interest has consequently been felt in the solution of the question, What significance (if any) has chlorophyl when found in animals? And since the only known use to which it could

in general be put (inferring from plants) is in decomposing carbonic acid, and thus aiding alimentation, it has become an important question to discover if this same physiological habit belongs to animal chlorophyl. If it can be proved that animal substance endowed with chlorophyl can, just as well as plant protoplasm similarly colored, break down carbonic acid and utilize its elements, then we remove the last formidable barrier between plant and animal protoplasm. If it should be shown, on the other hand, that when found in animals it is always functionally incapable of splitting up carbonic acid, it is true that we preserve a point of difference between plants and animals, but a result so negative would land us in a new difficulty, viz., that of explaining its presence by attributing to it some other function, and one unknown to plant chlorophyl. No sufficient explanation of this kind has hitherto been offered. In some cases a "protective resemblance" to vegetation would explain its occurrence; but in most cases this is out of the question.

Now, up to 1878 no evidence of value had ever been advanced to show that animal chlorophyl does enable its host to split up carbonic acid and give off the excess of oxygen resulting. In that year, however, Mr. Geddes, whose later work is referred to above, visited Roscoff and found there quantities of "the grass-green planarian (worm) *Convoluta Schultzii*, of which multitudes are to be found in certain localities on the coast, lying on the sand covered only by an inch or two of water, and apparently basking in the sun. It was only necessary to expose a quantity of these animals to direct sunlight to observe the rapid evolution of bubbles of gas, which, when collected and analyzed, yielded from forty-five to fifty-five per cent of oxygen."

Having obtained so much of valuable evidence, Mr. Geddes followed up his discovery by examining these green worms to see whether or not the animal protoplasm derives the same kind of benefit from its work as does plant protoplasm which is known, as a result of the co-operation of chlorophyl, to build up starch or starchy compounds.

This, indeed, proved to be the case, for he adds: "Both chemical and histological observations showed the abundant presence of starch in the green cells; and thus these planarians, and presumably also *Hydra*, *Spongilla*, etc., were proved to be truly 'vegetating animals.'"

The only link here needed is the full proof that the "grass-green planarian" owed his color to veritable chlorophyl. There is little or no reason to doubt it; yet, when we are told by Professor Lankester that in *Spongilla* alone among animals has spectroscopic investigation really *proved* the presence of that pigment, we can not help wishing that this confirmatory evidence had been obtained by Mr. Geddes.

Meantime slow progress had been making in a kindred subject. Before speaking of this, however, it must be said that chlorophyl is now known to be by no means a simple substance, but is rather made

up of several simpler compounds not well understood. Nor is it always green, though in that form it occurs most familiarly. Sometimes the true chlorophyl is obscured by some other color, and is nevertheless perfectly functional, physiologically speaking; for instance, a yellow color is particularly common in the lower forms of plants—as in the algæ.

In 1871 Cienkowski boldly announced his conviction that certain yellow cells, which, first pointed out by Huxley, had for some time attracted attention in the substance of radiolarians, were really no part of the animals themselves, but rather veritable algæ living in the animals. Haeckel had previously called them "liver-cells," and when starch was found in them he believed his view confirmed, as it is in the liver of the higher animals that glycogen—a form of starch—is constantly present. The views of Cienkowski made little progress, however, till 1879, when a distinguished morphologist, R. Hertwig, of Jena, who had previously taken sides with Haeckel, adduced reasons which inclined him to the belief that the yellow cells were "parasitic," as Cienkowski had considered them to be.

In the same year (1879) the brothers Hertwig concluded that the so-called pigment-bodies in the tentacles of certain sea-anemones are true algæ—plants, multiplying by tranverse division. Then followed quickly the paper by Dr. Brandt, referred to at the beginning of this review. His work was extensive, and resulted in a complete confirmation of the observations of Cienkowski and the Hertwigs. He fully believes that the yellow cells are true algæ, and was able to prove his points to his own satisfaction. He went, however, a step further, and announced his conviction that all animal chlorophyl is to be considered as located in associated vegetable organisms, which, together with the animal, make up "a partnership of plant and animal life." He unhesitatingly puts *Hydra viridis* and *Spongilla* (green variety) in this position, and thus disposes of all "vegetating animals," or animals living like plants endowed with chlorophyl.

In October, 1881, Mr. Geddes visited Naples for the sake of making further studies upon this subject, and in the paper in "Nature," referred to above (and which has been freely drawn upon in preparing this review), he gives a summary account of his work.

He devoted his attention at first to the yellow cells of *Radiolaria*, and was completely successful in demonstrating in them not only a cell-wall of cellulose and contents made up of protoplasm and nucleus, but he was also able to watch their growth both before and after the death of the animal; and, what was of special interest, he obtained a fair amount of evidence that certain tiny bubbles which in sunlight studded the radiolarians were really made up, in part at any rate, of oxygen. Besides this, he pronounces starch to be invariably present, and completely confirms the observations of Cienkowski and Brandt as to the survival and growth of the yellow cells long after the animal

has perished. The yellow pigment, he says, is identical with that of diatoms, and gives the same chemical reactions.

Turning his attention next to the sea-anemones, medusæ, etc., he was equally successful. He is convinced that the pigment-bodies are true algæ; and he records this remarkable experiment: "The exposure of a shoal of the beautiful blue pelagic Siphonophore, *Velella*, for a few hours, enabled me to collect a large quantity of gas which yielded from twenty-four to twenty-five per cent of oxygen. . . . But the most startling result was obtained by the exposure of the common *Anthea cereus* [sea-anemone], which yielded great quantities of gas, containing on an average from thirty-two to thirty-eight per cent of oxygen." He was able also to prove that this gas came from the associated algæ—specimens destitute of algæ giving off no oxygen whatever.

It is, therefore, now very certain that the yellow cells of radiolarians and the pigment-bodies of cœlenterates are in many cases true algæ living in the animal substance. Geddes's work, when added to that of Cienkowski, the Hertwigs, and Brandt, makes this so clear that we are justified in fully accepting their theory, and in hereafter considering the association of certain chlorophyl-bearing plants with certain animals as an established fact. It has been proposed to apply to this association the term *symbiosis*, and to designate animals which are thus supplied with algoid messmates as "symbiotic." So much for the "yellow cells" and pigment-bodies of radiolarians and cœlenterates. Dr. Brandt, it will be remembered, has expressed his belief that the green-colored *Hydra* and *Spongilla* are also symbiotic. In Mr. Geddes's paper nothing is said upon this subject, although, from a remark let fall near the close, it is plain that when the paper was written he did not accept Dr. Brandt's view, but would reserve *Hydra*, *Spongilla*, and *Convoluta*, for a special group of "vegetating animals" distinctly unlike those which are symbiotic.

Professor Lankester, however, while inclined to accept all that has been shown for symbiosis in the other cases, refuses most emphatically to apply that doctrine to *Hydra* and *Spongilla*. His dissent is all the more important, because he has paid much attention to the study of animal and plant pigments (especially with the spectroscope); and, because he was the first to establish the presence of chlorophyl in *Hydra* and *Spongilla*, he has a special right to be heard in this case. In the paper quoted above he attacks the subject with great vigor, and describes several important experiments tending to show that the green color of *Hydra* and *Spongilla* is due to chlorophyl bodies analogous rather to those structures in plants than to any algoid messmates. He fails to confirm Dr. Brandt's observations, and questions the virtue of his inferences so generally, that the two authorities are practically in diametrical opposition. It is obvious that still further studies must be made upon these so-called "vegetating animals," and that at present it would be highly unsafe to consider them as symbiotic.

Professor Lankester's paper is full of entertaining facts of his own discovery, but a number of experiments made by Mr. Blomfield, of Oxford, and University College, London, and quoted by Professor Lankester, are of special interest to us in this connection, as they furnish some evidence that the green *Hydra* does, like *Convoluta*, evolve oxygen in the sunlight. The observations are incomplete, but nevertheless of much value as they go to establish a second case in which animals destitute of yellow cells and pigment-bodies, but endowed presumably with true chlorophyl, do actually give off oxygen.

Meantime the reader can not have failed to perceive that the question as to the evolution of oxygen has become of secondary importance. It is nothing strange if algæ living in animals give off oxygen by virtue of their chlorophyl. In any special case we must now first inquire—Are the colored parts mere plants dwelling within the animal, or are they not? If not, then we must, if possible, apply the spectroscope for the study of the pigment (the chlorophyl group giving rather characteristic spectra), and then, if chlorophyl is present, test, if we can, for oxygen elimination. It is tolerably clear that the occurrence of native chlorophyl in animal protoplasm is not so wide-spread as was suspected before symbiosis was detected; yet the cases of *Hydra*, *Spongilla*, and *Convoluta* are still unsettled, and others may be added to their number: it must be granted, however, that the indications seem to be that in some cases animals may possess veritable chlorophyl arranged as in plants, giving the same spectrum and having the same power over carbonic acid.

At present it will be far more profitable to consider the significance of symbiosis than to speculate upon the result of observations belonging to the future. Professor Semper, in his work entitled "Animal Life," reminds us that, if it should come to pass [as it has] that we must consider much of the chlorophyl found in animals to be borne by vegetable messmates, we need not be surprised; since lichens—formerly supposed to be simple vegetables—have now been shown to be associated organisms—a fungus parasitic upon algæ. There is, indeed, much superficial resemblance between the two phenomena, and it is said to have been from the literature of lichens that the expressive word, *symbiosis*, was borrowed. In truth, there is really less analogy than at first appears; and, as there is no reason for considering the lichens as other than interesting and complicated cases of parasitism, we may hereafter, I think, reserve the word *symbiosis* for the description of that very different association of algæ with animals which it has been the purpose of the writer to elucidate. The word *zoöphyte* might, indeed, be used here with an accurate meaning had it not already a very definite (though utterly senseless) use in pseudo-scientific books and minds.

Mr. Geddes pictures at considerable length the probable physiological relationship between the organisms associated in symbiosis;

and in what comes hereafter we must to a great extent follow his lead. The algæ which are found in animal substance have been referred to above as "parasitic," but it is chiefly to avoid the use of this term that the more accurate one (symbiosis) has been employed. A closer analogy than that offered by the lichens would be, it seems to me, afforded by any perfect plant—an oak, for example. Here the colorless cells—of the root, let us say—are bound to live at the expense of the green cells in the stem and leaves. Yet we do not think of this as a parasitic event. The root-cell is rather a unit in a vast colony of units (cells) associated for mutual benefit. The green cell gets quite as much good from the root-cell as the latter gets from the green cell; water and salts are exchanged by the root-cells for sugary matters and other things readily made use of by any cell, and no harm (as would be the case in parasitism), but rather much good, is done by the exchange. Evidently the oxygen thrown off by the alga is precisely what the plant needs, and the carbonic acid and nitrogenous waste eliminated by the animal is most useful to the alga. Moreover, the algæ gain the advantage of ready locomotion with their host, and the animal can go further into unfavorable media when stocked with algæ ready to build up starches and sugary matters from carbonic acid and water. If either dies, the other is the gainer; since the algæ can thrive on the products of animal decomposition, and algæ—digestible, i. e., dead algæ—are much esteemed by most animals.

The whole burden of the physiological history of symbiosis is forcibly summed up by Mr. Geddes as follows: "Thus, then, for a vegetable cell no more ideal existence can be imagined than that within the body of an animal cell of sufficient vital activity to manure it with carbonic acid and nitrogen waste, yet of sufficient transparency to allow the free entrance of the necessary light. And, conversely, for an animal cell there can be no more ideal existence than to contain a vegetable cell, constantly removing its waste products, supplying it with oxygen and starch, and being digestible after death. . . . In short, we have here the relation of the animal and the vegetable world reduced to the simplest and closest conceivable form.

"It must be by this time sufficiently obvious that this remarkable association of plant and animal is by no means to be termed a case of parasitism. If so, the animals so infested would be weakened, whereas their exceptional success in the struggle for existence is evident. *Anthea cereus*, which contains most algæ, probably far outnumbers all the other species of sea-anemones put together, and the radiolarians, which contain yellow cells, are far more abundant than those which are destitute of them. . . . Such an association is far more complex than that of the fungus and alga in the lichen, and indeed stands unique in physiology as the highest development, not of parasitism, but of the reciprocity between the animal and vegetable kingdoms."

The foregoing paper was written several months ago, and since that time important contributions to the subject have been made by Geddes, Hamann, Jickeli, Entz, and especially by Brandt. The latter has published a summary of the whole matter, enriching it by observations of his own made at the zoölogical station at Naples. Brandt attaches less physiological significance to symbiosis than does Geddes, from whom he still differs in considering even *Hydra* and *Spongilla* as symbiotic and not "vegetating" animals. At present the views of Brandt, as laid down in his last paper (see "Mitt. aus zool. Stat. Neapel," iv, ii, 1883), seem likely to prevail; and in that article the student will find a complete literature and a full discussion of the whole subject.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XIII.

THE process of frying follows next in natural order to those of roasting and grilling. A little reflection will show that in frying the heat is not communicated to the food by radiation from a heated surface at some distance, but by direct contact with the heating medium, which is the hot fat commonly, but erroneously, described as "boiling fat."

As these papers are intended for intelligent readers who desire to understand the philosophy of the common processes of cookery, so far as they are understandable, this fallacy concerning boiling fat should be pushed aside at once.

Generally speaking, ordinary animal fats are not boilable under the pressure of our atmosphere (one of the constituent fatty acids of butter, butyric acid, is an exception; it boils at 314° Fahr.). Before their boiling-point, i. e., the temperature at which they pass completely into the state of vapor, is reached, their constituents are more or less dissociated or separated by the repulsive agency of the heat, new compounds being in many cases formed by recombinations of their elements.

When water is heated to 212° it is converted completely into a gas, which gas returns to the fluid state without any loss on cooling below 212°. In like manner if we raise an essential-oil, such as turpentine, to 320°, or oil of peppermint to 340°, or orange-peel oil to 345°, or patchouli to 489°, and other such oils to various other temperatures, they pass into a state of vapor, and these vapors, when cooled, recondense into their original form of liquid oil without alteration. Hence they are called "volatile oils," while the greasy oils which can not

thus be distilled (in which animal fats are included) are called "fixed oils."

A very simple practical means of distinguishing these is the following: Make a spot of the oil to be tested on clean blotting-paper. Heat this by holding it above a spirit-lamp flame, or by toasting before a fire. If the oil is volatile, the spot disappears; if fixed, it remains as a spot of grease until the heat is raised high enough to char the paper, of which charring (a result of the dissociation above-named) the oil partakes.

But the practical cook may say, "This is wrong, for the fat in my frying-pan does boil, I see it boil, and I hear it boil." The reply to this is, that the lard, or dripping, or butter that you put into your frying-pan is oil mixed with water, and that it is not the oil but the water that you see boiling. To prove this, take some fresh lard, as usually supplied, and heat it in any convenient vessel, raising the temperature gradually. Presently, it will begin to splutter. If you try it with a thermometer you will find that this spluttering-point agrees with the boiling-point of water, and if you use a retort you may condense and collect the splutter-matter, and prove it to be water. So long as the spluttering continues, the temperature of the melted fat, i. e., the oil, remains about the same, the water-vapor carrying away the heat. When all the water is driven off, the liquid becomes quiescent, in spite of its temperature, rising from 212° to near 400°, then a smoky vapor comes off and the oil becomes darker; this vapor is not vapor of lard, but vapor of separated and recombined constituents of the lard, which is now suffering dissociation, the volatile products passing off while the non-volatile carbon (i. e., lard-charcoal) remains behind, coloring the liquid. If the heating be continued, a residuum of this carbon, in the form of soft coke or charcoal, will be all that remains in the heated vessel.

We may now understand what happens when something humid—say a sole—is put into a frying-pan which contains fat heated above 212°. Water, when suddenly heated above its boiling-point, is a powerful explosive, and may be very dangerous, simply because it expands to 1,728 times its original bulk when converted into steam. Steam-engine boilers and the boilers of kitchen-stoves sometimes explode simply by becoming red-hot while dry, and then receiving a little water which suddenly expands to steam.

The noise and spluttering that are started immediately the sole is immersed in the hot fat, are due to the explosions of a multitude of small bubbles formed by the confinement of the suddenly expanding steam in the viscous fat, from which it releases itself with a certain degree of violence. It is evident that, to effect this amount of eruptive violence, the temperature must be considerably above the boiling-point of the exploding water. If it were only just at the boiling-point, the water would boil quietly.

As we all know, the flavor and appearance of a boiled sole or mackerel are decidedly different from those of a fried sole or mackerel, and it is easy to understand that the different results of these cooking processes are to some extent due to the difference of temperature to which the fish is subjected.

The surface of the fried fish, like that of the roasted or grilled meat, is "browned." What is the nature, the chemistry of this browning?

I have endeavored to find some answer to this question, that I might quote with authority, but no technological or purely chemical work within my reach supplies such answer. Rumford refers to it as essential to roasting, and provides for it in the manner already described, but he goes no further into the philosophy of it than admitting its flavoring effect.

I must therefore struggle with the problem in my own way as I best can. Has the gentle reader ever attempted the manufacture of "hard-bake," or "toffy," or "butter-scotch," by mixing sugar with butter, fusing the mixture, and heating further until the well-known hard, brown confection is produced? I venture to call this fried sugar. If heated simply without the butter it may be called baked sugar. The scientific name for this baked sugar is *caramel*.

The chemical changes that take place in the browning of sugar have been more systematically studied than those which occur in the constituents of flesh when browned in the course of ordinary cookery. Believing them to be nearly analogous, I will state, as briefly as possible, the leading facts concerning the sugar.

Ordinary sugar is crystalline, i. e., when it passes from the liquid to the solid state it assumes regular geometrical forms. If the solidification takes place undisturbed and slowly, the geometric crystals are large, as in sugar-candy; if the water is rapidly evaporated with agitation, the crystals are small, and the whole mass is a granular aggregation of crystals, such as we see in loaf-sugar. If this crystalline sugar be heated to about 320° it fuses, and without any change of chemical composition undergoes some sort of internal physical alteration that makes it cohere in a different fashion. (The learned name for this is *allotropism*, and the substance is said to be *allotropic*, other conditioned; or *dimorphic*, two-shaped.) Instead of being crystalline the sugar now becomes vitreous, it solidifies as a transparent amber-colored glass-like substance, the well-known barley-sugar, which differs from crystalline sugar, not only in this respect, but has a much lower melting-point; it liquefies between 190° and 212°, while loaf-sugar does not fuse below 320°. Left to itself, vitreous sugar returns gradually to its original condition, loses transparency, and breaks up into small crystals. In doing this, it gives out the heat which during its vitreous condition had been doing the work of breaking up its crystalline structure, and therefore was not manifested as temperature.

This return to the crystalline condition is retarded by adding vinegar or mucilaginous matter to the heated sugar, hence the confectioners' name of "barley-sugar," which, in one of its old-fashioned forms, was prepared by boiling down ordinary sugar in a decoction of pearl barley.

The French cooks and confectioners carry on the heating of sugar through various stages bearing different technical names, one of the most remarkable of which is a splendid crimson variety, largely used in fancy sweetmeats, and containing no foreign coloring-matter, as commonly supposed. Though nothing is added, something is taken away, and this is some of the chemically-combined water of the original sugar, in the parting with which not only a change of color occurs, but also a modification of flavor, as anybody may prove by experiment.

When the temperature is gradually raised to 420°, the sugar loses two equivalents of water, and becomes *caramel*—a dark-brown substance, no longer sweet, but having a new flavor of its own. It further differs from sugar by being incapable of fermentation. Its analogies to the crust of bread and the "brown" of cooked animal food will be further discussed in my next.

XIV.

In my last I described the dissociation of sugar by heat and the formation of caramel, to illustrate by simple example the "browning" of other kinds of food. I might have added, in connection with this cookery of sugar, an historical connection with one of the lost arts of the kitchen—viz., the "spinning" of sugar. Within the reach of my own recollection no evening party could pretend to be stylish unless the supper-table was decorated with a specimen of this art—a temple, a pagoda, or something of the sort done in barley-sugar. These were made by raising the sugar to 320°, when it fused and became amorphous, or vitreous, as already described. The cook then dipped a skewer into it, the melted vitreous sugar adhered to this and was drawn out as a thread, which speedily solidified by cooling. While in the act of solidification it was woven into the desired form, and the skillful artist did this with wonderful rapidity. I once witnessed with childish delight the spinning of a great work of art by a French cook in St. James's Palace. It was a ship in full sail, the sails of edible wafer, the hull a basket-work of spun sugar, the masts of massive sugar-sticks, and the rigging of delicate threads of the same. As nearly as I can remember, the whole was completed in about an hour.

But to return from high art to chemical science. The conversion of sugar into caramel is, as already stated, attended with a change of flavor: a kind of bitterness replaces the sweetness. This peculiar flavor, judiciously used, is a powerful adjunct to cookery, and one which is shamefully neglected in our ordinary English domestic

kitchens. To test this, go to one of those Swiss restaurants originally instituted in this country by that enterprising Ticinese, the late Carlo Gatti, and which are now so numerous in London and our other large towns; call for *macaroni al sugo;* notice the rich, brown gravy, the "sugo." Many an English cook would use half a pound of gravy-beef to produce the like, but the basis of this is half an ounce of sugar, or even less; the sugar is browned by heating, not quite up to the caramel state. Burnt onion may contribute, but this is only another form of caramel with more savory properties.

While engaged upon your macaroni, look around at the other dishes served to other customers. Instead of the pale slices of meat spread out in a little puddle of pale, watery liquid, that are served in English restaurants of corresponding class, you will see dainty morsels, covered with rich, brown gravy, or surrounded by vegetables immersed in the same. This sugo is greatly varied according to the requirements, by additions of stock-broth, tarragon-vinegar, ketchup, etc., etc., but burnt sugar, or burnt onions, or burnt something is the basis of it all, sugar being the cheapest.

To further test the flavoring properties of browning, take some eels cut up as usual for stewing; divide into two portions; stew one brutally—by this I mean simply in a little water—serving them with this water as a pale gravy or juice. Let the second portion be well fried, fully browned, then stewed, and served with brown gravy. Compare the result. Make a corresponding experiment with a beef-steak. Cut it in two portions: stew one brutally in plain water; fry the other, then stew it and serve brown.

Take a highly-baked loaf, better one that is black outside; scrape off the film or crust that is quite black, i. e., completely carbonized, and you will come to a rich brown layer, especially if you operate upon the bottom crust. Slice off a thin shaving of this, and eat it critically. Mark its high flavor as compared with the comparatively insipid crumb of the same loaf, and note especially the resemblance between this flavor and that of the caramel from sugar, and that of the browned eels and browned steak. A delicate way of detecting the flavor due to the browning of bread is to make two bowls of bread and milk in the same manner, one with the crust, the other with the crumb of the same loaf. I am not suggesting these as examples of better or worse flavor, but as evidence of the fact that much flavor of some sort is generated. It may be out of place, as I think it is, in the bread and milk, or it may be added with much advantage to other things, as it is by the cook who manipulates caramel and its analogues skillfully.

The largest constituent of bread is starch. Excluding water, it constitutes about three fourths of the weight of good wheaten flour. Starch differs but little from sugar in composition. It is easily converted into sugar by simply heating it with a little sulphuric acid, and

by other means of which I shall have to speak more fully hereafter when I come to the cookery of vegetables. When simply heated, it is converted into dextrin or "British gum," largely used as a substitute for gum-arabic. If the heat is continued a change of color takes place; it grows darker and darker until it blackens just as sugar does, the final result being nearly the same. Water is driven off in both cases, but in carbonizing sugar we start with more water, sugar being starch plus water or the elements of water. Thus the brown material of bread-crust or toast is nearly identical with caramel.

I have often amused myself by watching what occurs when toast-and-water is prepared, and I recommend my readers to repeat the observation. Toast a small piece of bread to blackness, and then float it on water in a glass vessel. Leave the water at rest, and direct your attention to the under side of the floating toast. Little thread-like streams of brown liquid will be seen descending in the water. This is a solution of the substance which, if I mistake not, is a sort of caramel, and which ultimately tinges all the water.

Some years ago I commenced a course of experiments with this substance, but did not complete them. In case I should never do so, I will here communicate the results attained. I found that this starch caramel is a disinfectant, and that sugar caramel also has some disinfecting properties. I am not prepared to say that it is powerful enough to disinfect sewage, though at the time I had a narrow escape from the Great-Seal Office, where I thought of patenting it for this purpose as a non-poisonous disinfectant that may be poured into rivers in any quantity without danger. Though it may not be powerful enough for this, it has an appreciable effect on water slightly tainted with decomposing organic matter.

This is a very curious fact. We do not know who invented toast-and-water, nor, so far as I can learn, has any theory of its use been expounded, yet there is extant a vague, popular impression that the toast has some sort of wholesome effect on the water. I suspect that this must have been originally based on experience, probably on the experience of our forefathers or foremothers living in country places where stagnant water was a common beverage, and various devices were adopted to render it potable.

Gelatine, fibrine, albumen, etc.—i. e., all the materials of animal food—as already shown, are composed, like starch and sugar, of carbon, hydrogen, and oxygen, with, in the case of these animal substances, the addition of nitrogen; but this does not prevent their partial carbonization (or "caramelizing," if I may invent a name to express the action which stops short of blackening). Animal fat is a hydrocarbon which may be similarly browned, and, if I am right in my generalization of all these browning processes, an important practical conclusion follows, viz., that cheap soluble caramel made by skillfully heating common sugar, is really, as well as apparently, as valuable

an element in gravies, etc., as the far more expensive coloring-matter of brown meat-gravies, and that our English cooks should use it far more liberally than they usually do.

Its preparation is easy enough; the sugar should be gradually heated till it assumes a rich brown color and has lost its original sweetness. If carried just far enough, and not too far, the result is easily soluble in hot water, and the solution may be kept for a long time, as it is by cooks who understand its merits. In connection with the idea of its disinfecting action, I may refer to the cookery of tainted meat or "high" game. A hare that is repulsively advanced when raw, may by much roasting and browning become quite wholesome, and such is commonly the case in the ordinary cooking of hares. If it were boiled or merely stewed (without preliminary browning) in this condition, it would be quite disgusting to ordinary palates.

A leg of mutton for roasting should be hung until it begins to become odorous; for boiling it should be as fresh as possible. This should be especially remembered now that we have so much frozen meat imported from the antipodes. When duly thawed it is in splendid condition for roasting, but is not usually so satisfactory when boiled. I may here mention incidentally that such meat is sometimes unjustly condemned on account of its displaying a raw center when cooked. This arises from imperfect thawing. The heat required to thaw a given weight of ice and bring it up to 60°, is about the same as demanded for the cookery of an equal quantity of meat, and therefore, while the thawed portions of the meat is being cooked, the frozen portion is but just thawed, and remains quite raw.

A much longer time is demanded for thawing—i. e., supplying 142° of latent heat—than might be supposed. To ascertain whether the thawing is completed, drive an iron skewer through the thickest part of the joint. If there is a core of ice within, it will be distinctly felt by its resistance.

XV.

Before leaving the subject of caramel, I should say a few words about French coffee, or "coffee as in France," of which we hear so much. There are two secrets upon which depend the excellence of our neighbors in the production of this beverage: First, economy in using the water; second, flavoring with caramel. As regards the first, it appears that English housewives have been demoralized by the habitual use of tea, and apply to the infusion of coffee the popular formula for that of tea, "a spoonful for each person and one for the pot."

The French after-dinner coffee-cup has about one third of the liquid capacity of a full-sized English breakfast-cup, but the quantity of solid coffee supplied to each cupful is more than equal to that ordinarily allowed for the larger English measure of water.

Besides this, the coffee is commonly though not universally flavored with a specially and skillfully prepared caramel, instead of the chiccory so largely used in England. Much of the so-called "French coffee" now sold by our grocers in tins is caramel flavored with coffee, rather than coffee flavored with caramel; and many shrewd English housewives have discovered that, by mixing the cheapest of these French coffees with an equal quantity of pure coffee, they obtain a better result than with the common domestic mixture of three parts coffee and one of chiccory.

A few months ago a sample of "coffee-finings" was sent to me for chemical examination, that I might certify to its composition and wholesomeness. I described it in my report as "a caramel, with a peculiarly rich aroma and flavor, evidently due to the vegetable juices or extractive matter naturally united with the saccharine substance from which it is prepared." I had no definite information of the exact nature of this saccharine substance, but have good reason to assume that it was a by-product of sugar-refining.

Neither the juice of the beet-root nor the sap of the sugar-cane consists entirely of pure sugar dissolved in pure water. They both contain other constituents common to vegetable juices, and some peculiar to themselves. These mucilaginous matters, when roughly separated, carry down with them some sugar, and form a sort of coarse sweet-wort, capable, by skillful treatment, of producing a rich caramel such as I received.

I tested its practical merits by making an infusion of pure coffee of fine quality, dividing this into two parts, adding to one a small quantity of the caramel, and leaving the other half unmixed. I found the infusion greatly improved in flavor by the admixture, and recognized the peculiarity which characterizes the coffee prepared by Gatti and his compatriots, whose numerous establishments are doing so much for the promotion of temperance in this country. The aroma of this particular caramel is peculiarly fine, and the greater part of it is soluble in boiling water; thus I was able to mix it by merely adding to the coffee as we add sugar.

I have used my best eloquence in trying to persuade the manufacturers to sell it separately, but have not yet succeeded. They seem to have had painful experience of the gastronomic bigotry of Englishmen, who refuse to eat or drink anything that is not hallowed by the sanction of their great-grandmothers, unless it is surreptitiously introduced by means of some device approaching as nearly as possible to a commercial swindle.

Returning to the subject of frying, we encounter a good illustration of the practical importance of sound theory. A great deal of fish and other kinds of food are badly and wastefully cooked in consequence of the prevalence of a false theory of frying. It is evident that many domestic cooks (not hotel or restaurant cooks) have a vague

idea that the metal plate forming the bottom of the frying-pan should directly convey the heat of the fire to the fried substance, and that the bit of butter or lard or dripping put into the pan is used to prevent the fish from sticking to it, or to add to the richness of the fish by smearing its surface.

The theory which I have suggested (see No. XIII, page 818) is that the melted fat cooks by convection of heat, just as water does in the so-called boiling of meat. If that is correct, it is evident that the fish, etc., should be completely immersed in a bath of melted fat or oil, and that the turning over demanded by the greased-plate theory is unnecessary. Well-educated cooks understand this distinctly, and use a deeper vessel than our common frying-pan, charge this with a quantity of fat sufficient to cover the fish, which is simply laid upon a wire support, or frying-basket, and left in the hot fat until the browning of its surface, or of the flour or bread-crumbs with which it is coated, indicates the sufficiency of the cookery.

At first sight this appears extravagant, as compared with the practice of greasing the bottom of the pan with a little dab of fat; but any housewife who will apply to the frying of sprats, herrings, etc., the method of quantitative inductive research, described and advocated by Lord Bacon in his "Novum Organum Scientarum," may prove the contrary.

"Must I read the 'Novum Organum,' and buy another dictionary, in order to translate all this?" she may exclaim in despair. "No!" is my reply. This Baconian inductive method, to which we are indebted for all the triumphs of modern science, is nothing more nor less than the systematic and orderly application of common sense and definite measurement to practical questions. In this case it may be applied simply by frying a weighed quantity of any particular kind of fish—say sprats—in a weighed quantity of fat used as a bath; then weighing the fat that remains and subtracting the latter weight from the first, to determine the quantity consumed. If the frying be properly performed, and this quantity compared with that which is consumed by the method of merely greasing the pan-bottom, the bath-frying will be proved to be the more economical as well as the more efficient method.

The reason of this is simply that much or all of the fat is burned and wasted when only a thin film is spread on the bottom of the pan, while no such waste occurs when the bath of fat is properly used. The temperature at which the dissociation of fat *commences* is below that required for delicately browning the surface of the fish itself, or of the flour or bread-crumbs, and therefore no fat is burned away from the bath, as it is by the overheated portions of a merely greased frying-pan; and, as regards the quantity adhering to the fish itself, this may be reduced to a minimum by withdrawing it from the bath when *the whole* is uniformly at the maximum cooking temperature, and

allowing the fluid fat to drain off at once. When cooked on the greased plate, one side is necessarily cooling, and the fat settling down into the fish, while the other is being heated from below.

SOME UNSOLVED PROBLEMS IN GEOLOGY.*

By Dr. J. W. DAWSON.

I.

MY predecessor in office remarked, in the opening of his address, that two courses are open to the retiring president of this Association in preparing the annual presidential discourse—he may either take up some topic relating to his own specialty, or he may deal with various or general matters relating to science and its progress. A geologist, however, is not necessarily tied up to one or the other alternative. His subject covers the whole history of the earth in time. At the beginning it allies itself with astronomy and physics and celestial chemistry. At the end it runs into human history, and is mixed up with archæology and anthropology. Throughout its whole course it has to deal with questions of meteorology, geography, and biology. In short, there is no department of physical or biological science with which geology is not allied, or at least on which the geologist may not presume to trespass. When, therefore, I announce as my subject on the present occasion some of the unsolved problems of this universal science, you need not be surprised if I should be somewhat discursive.

Perhaps I shall begin at the utmost limits of my subject by remarking that in matters of natural and physical science we are met at the outset with the scarcely solved question as to our own place in the nature which we study, and the bearing of this on the difficulties we encounter. The organism of man is decidedly a part of nature. We place ourselves, in this aspect, in the sub-kingdom vertebrata, and class mammalia, and recognize the fact that man is the terminal link in a chain of being, extending throughout geological time. But the organism is not all of man ; and, when we regard man as a scientific animal, we raise a new question. If the human mind is a part of nature, then it is subject to natural law ; and nature includes mind as well as matter. On the other hand, without being absolute idealists, we may hold that mind is more potent than matter, and nearer to the real essence of things. Our science is in any case necessarily dualistic, being the product of the reaction of mind on nature, and must be largely subjective and anthropomorphic. Hence, no doubt, arise much of the controversy of science and much of the unsolved difficulty.

* Address of the President of the American Association for the Advancement of Science, delivered at Minneapolis, August 15, 1883. Reprinted from "Science."

We recognize this when we divide science into that which is experimental, or depends on apparatus, and that which is observational and classificatory—distinctions, these, which relate not so much to the objects of science as to our methods of pursuing them. This view also opens up to us the thought that the domain of science is practically boundless; for who can set limits to the action of mind on the universe, or of the universe on mind? It follows that science must be limited on all sides by unsolved mysteries; and it will not serve any good purpose to meet these with clever guesses. If we so treat the enigmas of the sphinx Nature, we shall surely be devoured. Nor, on the other hand, must we collapse into absolute despair, and resign ourselves to the confession of inevitable ignorance. It becomes us, rather, boldly to confront the unsolved questions of Nature, and to wrestle with their difficulties till we master such as we can, and cheerfully leave those we can not overcome to be grappled with by our successors.

Fortunately, as a geologist, I do not need to invite your attention to those transcendental questions which relate to the ultimate constitution of matter, the nature of the ethereal medium filling space, the absolute difference or identity of chemical elements, the cause of gravitation, the conservation and dissipation of energy, the nature of life, or the primary origin of bioplasmic matter. I may take the much more humble *rôle* of an inquirer into the unsolved or partially solved problems which meet us in considering that short and imperfect record which geology studies in the rocky layers of the earth's crust, and which leads no further back than to the time when a solid rind had already formed on the earth and was already covered with an ocean. This record of geology covers but a small part of the history of the earth and of the system to which it belongs, nor does it enter at all into the more recondite problems involved; still it forms, I believe, some necessary preparation, at least, to the comprehension of these.

What do we know of the oldest and most primitive rocks? At this moment the question may be answered in many and discordant ways; yet the leading elements of the answer may be given very simply. The oldest rock formation known to geologists is the lower Laurentian, the fundamental gneiss, the Lewisian formation of Scotland, the Ottawa gneiss of Canada. This formation of enormous thickness corresponds to what the older geologists called the fundamental granite—a name not to be scouted, for gneiss is only a stratified granite. Perhaps the main fact in relation to this old rock is that it is a gneiss; that is, a rock at once bedded and crystalline, and having for its dominant ingredient the mineral orthoclase—a compound of silica, alumina, and potash—in which are imbedded, as in a paste, grains and crystals of quartz and hornblende. We know very well, from its texture and composition, that it can not be a product of mere heat; and, being a bedded rock, we infer that it was laid down layer

by layer, in the manner of aqueous deposits. On the other hand, its chemical composition is quite different from that of the muds, sands, and gravels usually deposited from water. Their special characters are caused by the fact that they have resulted from the slow decay of rocks like these gneisses, under the operation of carbonic acid and water, whereby the alkaline matter and the more soluble part of the silica have been washed away, leaving a residue mainly silicious and aluminous. Such more modern rocks tell of dry land subjected to atmospheric decay and rain-wash. If they have any direct relation to the old gneisses, they are their grandchildren, not their parents. On the contrary, the oldest gneisses show no pebbles, or sand, or limestone—nothing to indicate that there was then any land undergoing atmospheric waste, or shores with sand and gravel. For all that we know to the contrary, these old gneisses may have been deposited in a shoreless sea, holding in solution or suspension merely what it could derive from a submerged crust recently cooled from a state of fusion, still thin, and exuding here and there through its fissures heated waters and volcanic products.

It is scarcely necessary to say that I have no confidence in the supposition of unlike composition of the earth's mass on different sides, on which Dana has partly based his theory of the origin of continents. The most probable conception seems to be that of Lyell; namely, a molten mass, uniform except in so far as denser material might exist toward its center, and a crust at first approximately even and homogeneous, and subsequently thrown into great bendings upward and downward. This question has recently been ably discussed by Mr. Crosby in the London "Geological Magazine." *

In short, the fundamental gneiss of the lower Laurentian may have been the first rock ever formed; and in any case it is a rock formed under conditions which have not since recurred, except locally. It constitutes the first and best example of these chemico-physical, aqueous or aqueo-igneous rocks, so characteristic of the earliest period of the earth's history. Viewed in this way, the lower Laurentian gneiss is probably the oldest kind of rock we shall ever know—the limit to our backward progress, beyond which there remains nothing to the geologist except physical hypotheses respecting a cooling, incandescent globe. For the chemical conditions of these primitive rocks, and what is known as to their probable origin, I must refer you to my friend Dr. Sterry Hunt, to whom we owe so much of what is known of the older crystalline rocks,† as well as of their literature and the questions which they raise. My purpose here is to sketch the remarkable difference which we meet as we ascend into the middle and upper Laurentian.

In the next succeeding formation, the true lower Laurentian of Logan, the Grenville series of Canada, we meet with a great and sig-

* June, 1883.

† Hunt, "Essays on Chemical Geology."

nificant change. It is true we have still a predominance of gneisses which may have been formed in the same manner with those below them; but we find these now associated with great beds of limestone and dolomite, which must have been formed by the separation of calcium and magnesium carbonates from the sea-water, either by chemical precipitation or by the agency of living beings. We have also quartzite, quartzose gneisses, and even pebble-beds, which inform us of sand-banks and shores. Nay, more, we have beds containing graphite which must be the residue of plants, and iron-ores which tell of the deoxidation of iron oxide by organic matters. In short, here we have evidence of new factors in world-building—of land and ocean, of atmospheric decay of rocks, of deoxidizing processes carried on by vegetable life on the land and in the waters, of limestone-building in the sea. To afford material for such rocks, the old Ottawa gneiss must have been lifted up into continents and mountain-masses. Under the slow but sure action of the carbonic dioxide dissolved in rain-water, its feldspar had crumbled down in the course of ages. Its potash, soda, lime, magnesia, and part of its silica, had been washed into the sea, there to enter into new combinations and to form new deposits. The crumbling residue of fine clay and sand had been also washed down into the borders of the ocean, and had been there deposited in beds.* Thus the earth had entered into a new phase, which continues onward through the geological ages; and I place in your hands one key for unlocking the mystery of the world when I affirm that this great change took place, this new era was inaugurated, in the midst of the Laurentian period.

Was not this time a fit period for the first appearance of life? Should we not expect it to appear, independently of the evidence we have of the fact? I do not propose to enter here into that evidence, more especially in the case of the one well-characterized Laurentian fossil, *Eozoön Canadense*. I have already amply illustrated it elsewhere. I would merely say here, that we should bear in mind that in this latter half of the lower Laurentian, or, if we so choose to style it, middle Laurentian period, we have the conditions required for life in the sea and on the land; and, since in other periods we know that life was always present when its conditions were present, it is not unreasonable to look for the first traces of life in this formation, in which we find for the first time the completion of those physical arrangements which make life, in such forms of it as exist on our planet, possible.

This is also a proper place to say something of the doctrine of what is termed "metamorphism." The Laurentian rocks are undoubtedly greatly changed from their original state, more especially in the matters of crystallization and the formation of disseminated minerals by

* Dr. Hunt has now in preparation for the press an important paper on this subject, read before the National Academy of Sciences.

the action of heat and heated water. Sandstones have thus passed into quartzites, clays into slates and schists, limestones into marbles. So far metamorphism is not a doubtful question; but, when theories of metamorphism go so far as to suppose an actual change of one element for another, they go beyond the bounds of chemical credibility: yet such theories of metamorphism are often boldly advanced and made the basis of important conclusions. Dr. Hunt has happily given the name "metasomatosis" to this imaginary and impossible kind of metamorphism, which may be regarded as an extreme kind of evolution, akin to some of those forms of that theory employed with reference to life, but more easily detected and exposed. I would have it to be understood that, in speaking of the metamorphism of the older crystalline rocks, it is not to this metasomatosis that I refer, and that I hold that rocks which have been produced out of the materials de composed by atmospheric erosion can never, by any process of metamorphism, be restored to the precise condition of the Laurentian rocks. Thus there is in the older formations a genealogy of rocks which, in the absence of fossils, may be used with some confidence, but which does not apply to the more modern deposits. Still, nothing in geology absolutely perishes or is altogether discontinued; and it is probable that, down to the present day, the causes which produced the old Laurentian gneiss may still operate in limited localities. Then, however, they were general, not exceptional. It is further to be observed that the term "gneiss" is sometimes of wide and even loose application. Besides the typical orthoclase and hornblendic gneiss of the Laurentian, there are micaceous, quartzose, garnetiferous, and many other kinds of gneiss; and even gneissose rocks, which hold labradorite or anorthite instead of orthoclase, are sometimes, though not accurately, included in the term.

The Grenville series, or middle Laurentian, is succeeded by what Logan in Canada called the upper Laurentian, and which other geologists have called the Norite or Norian series. Here we still have our old friends the gneisses, but somewhat peculiar in type; and associated with them are great beds rich in lime-feldspar—the so-called labradorite and anorthite rocks. The precise origin of these is uncertain, but this much seems clear, namely, that they originated in circumstances in which the great limestones deposited in the lower or middle Laurentian were beginning to be employed in the manufacture, probably by aqueo-igneous agencies, of lime-feldspars. This proves the Norian rocks to be much younger than the Laurentian, and that, as Logan supposed, considerable earth-movements had occurred between the two, implying lapse of time.

Next we have the Huronian of Logan—a series much less crystalline and more fragmentary, and affording more evidence of land elevation and atmospheric and aqueous erosion, than any of the others. It has great conglomerates, some of them made up of rounded pebbles

of Laurentian rocks, and others of quartz-pebbles, which must have been the remains of rocks subjected to very perfect erosion. The pure quartz-rocks tell the same tale, while limestones and slates speak also of chemical separation of the materials of older rocks. The Huronian evidently tells of movements in the previous Laurentian, and changes in its texture so great that the former may be regarded as a comparatively modern rock, though vastly older than any part of the palæozoic series.

Still later than the Huronian is the great micaceous series called by Hunt the Mont Alban or White Mountain group, and the Taconian or lower Taconic of Emmons, which recalls in some measure the conditions of the Huronian. The precise relations of these to the later formations, and to certain doubtful deposits around Lake Superior, can scarcely be said to be settled, though it would seem that they are all older than the fossiliferous Cambrian rocks which practically constitute the base of the palæozoic. I have, I may say, satisfied myself, in regions which I have studied, of the existence and order of these rocks as successive formations, though I would not dogmatize as to the precise relations of those last mentioned, or as to the precise age of some disputed formations which may either be of the age of the older eozoic formations, or may be peculiar kinds of palæozoic rocks modified by metamorphism. Probably neither of the extreme views now agitated is absolutely correct.

After what has been said, you will perhaps not be astonished that a great geological battle rages over the old crystalline rocks. By some geologists they are almost entirely explained away, or referred to igneous action or to the alteration of ordinary sediments. Under the treatment of another school, they grow to great series of pre-Cambrian rocks, constituting vast systems of formations, distinguishable from each other, not by fossils, but by differences of mineral character. I have already indicated the manner in which I believe the dispute will ultimately be settled, and the President of the Geological Section will treat it more fully in his opening address.

After the solitary appearance of Eozoön in the Laurentian, and of a few uncertain forms in the Huronian and Taconian, we find ourselves in the Cambrian, in the presence of a nearly complete invertebrate fauna of protozoa, polyps, echinoderms, mollusks, and crustacea; and this not confined to one locality merely, but apparently extended simultaneously throughout the ocean. This sudden incoming of animal life, along with the subsequent introduction of successive groups of invertebrates, and finally of vertebrate animals, furnishes one of the greatest of the unsolved problems of geology, which geologists were wont to settle by the supposition of successive creations. In an address delived at the Detroit meeting of the Association in 1875, I endeavored to set forth the facts as to this succession, and the general principles involved in it, and to show the insufficiency of the theo-

ries of evolution suggested by biologists to give any substantial aid to the geologist in these questions. In looking again at the points there set forth, I find they have not been invalidated by subsequent discoveries, and that we are still nearly in the same position with respect to these great questions that we were in at that time—a singular proof of the impotency of that deductive method of reasoning which has become fashionable among naturalists of late. Yet the discussions of recent years have thrown some additional light on these matters; and none more so than the mild disclaimers with which my friend Dr. Asa Gray and other moderate and scientific evolutionists have met the extreme views of such men as Romanes, Haeckel, Lubbock, and Grant Allen. It may be useful to note some of these as shedding a little light on this dark corner of our unsolved problems.

It has been urged, on the side of rational evolution, that this hypothesis does not profess to give an explanation of the absolute origin of life on our planet, or even of the original organization of a single cell or of a simple mass of protoplasm, living or dead. All experimental attempts to produce by synthesis the complex albuminous substances, or to obtain the living from the non-living, have so far been fruitless; and, indeed, we can not imagine any process by which such changes could be effected. That they have been effected we know; but the process employed by their Maker is still as mysterious to us as it probably was to him who wrote the words, "And God said, Let the waters swarm with swarmers." How vast is the gap in our knowledge and our practical power implied in this admission, which must, however, be made by every mind not absolutely blinded by a superstitious belief in those forms of words which too often pass current as philosophy!

But if we are content to start with a number of organisms ready made—a somewhat humiliating start, however—we still have to ask, How do these vary so as to give new species? It is a singular illusion in this matter, of men who profess to be believers in natural law, that variation may be boundless, aimless, and fortuitous, and that it is by spontaneous selection from varieties thus produced that development arises. But surely the supposition of mere chance and magic is unworthy of science. Varieties must have causes, and their causes and their effects must be regulated by some law or laws. Now, it is easy to see that they can not be caused by a mere innate tendency in the organism itself. Every organism is so nicely equilibrated, that it has no such spontaneous tendency, except within the limits set by its growth and the law of its periodical changes. There may, however, be equilibrium more or less stable. I believe all attempts hitherto made have failed to account for the fixity of certain, nay, of very many, types throughout geological time; but the mere consideration that one may be in a more stable state of equilibrium than another so far explains it. A rocking stone has no more spontaneous tendency

to move than an ordinary bowlder, but it may be made to move with a touch. So it probably is with organisms. But, if so, then the causes of variation are external, as in many cases we actually know them to be; and they must depend on instability or change in surroundings, and this so arranged as not to be too extreme in amount, and to operate in some determinate direction. Observe how remarkable the unity of the adjustments involved in such a supposition. How superior they must be to our rude and always more or less unsuccessful attempts to produce and carry forward varieties and races in definite directions! This can not be chance. If it exists, it must depend on plans deeply laid in the nature of things, else it would be most monstrous magic and causeless miracle. Still more certain is this conclusion when we consider the vast and orderly succession made known to us by geology, and which must have been regulated by fixed laws, only a few of which are as yet known to us.

Beyond these general considerations, we have others of a more special character, based on paleontological facts, which show how imperfect are our attempts, as yet, to reach the true causes of the introduction of genera and species.

One is the remarkable fixity of the leading types of living beings in geological time. If, instead of framing, like Haeckel, fanciful phylogenies, we take the trouble, with Barrande and Gaudry, to trace the forms of life through the period of their existence, each along its own line, we shall be greatly struck with this, and especially with the continuous existence of many low types of life through vicissitudes of physical conditions of the most stupendous character, and over a lapse of time scarcely conceivable. What is still more remarkable is, that this holds in groups which, within certain limits, are perhaps the most variable of all. In the present world no creatures are individually more variable than the protozoa; as, for example, the foraminifera and the sponges. Yet these groups are fundamentally the same, from the beginning of the palæozoic until now; and modern species seem scarcely at all to differ from specimens procured from rocks at least half-way back to the beginning of our geological record. If we suppose that the present sponges and foraminifera are the descendants of those of the Silurian period, we can affirm that, in all that vast lapse of time, they have, on the whole, made little greater change than that which may be observed in variable forms at present. The same remark applies to other low animal forms. In forms somewhat higher and less variable, this is equally noteworthy. The pattern of the venation of the wings of cockroaches and the structure and form of land-snails, gally-worms, and decapod crustaceans were all settled in the carboniferous age in a way that still remains. So were the foliage and the fructification of club-mosses and ferns. If at any time members of these groups branched off, so as to lay the foundation of new species, this must have been a very rare and exceptional occurrence,

and one demanding even some suspension of the ordinary laws of nature.

Certain recent utterances of eminent scientific men in England and France are most instructive with reference to the difficulties which encompass this subject. Huxley, at present the leader of English evolutionists, in his "Rede Lecture"* delivered at Cambridge, England, holds that there only two "possible alternative hypotheses" as to the origin of species: 1. That of "construction," or the mechanical putting together of the materials and parts of each new species separately; and, 2. That of "evolution," or that one form of life "proceeded from another" by the "establishment of small successive differences." After comparing these modes, much to the disadvantage of the first, he concludes with the statement that "this was his case for evolution, which he rested wholly on arguments of the kind he had adduced"; these arguments being the threadbare false analogy of ordinary reproduction and the transformation of species, and the mere succession of forms more or less similar in geological time, neither of them having any bearing whatever on the origin of any species or on the cause of the observed succession. With reference to the two alternatives, while it is true that no certain evidence has yet been obtained—either by experiment, observation, or sound induction—as to the mode of origin of any species, enough is known to show that there are numerous possible methods, grouped usually under the heads of absolute creation, mediate creation, critical evolution, and gradual evolution. It is also true that almost the only thing we certainly know in the matter is, that the differences characteristic of classes, orders, genera, and species, must have arisen, not in one or two, but in many ways. An instructive commentary on the capacity of our age to deal with these great questions is afforded by the fact that this little piece of clever mental gymnastic should have been practiced in a university lecture and in presence of an educated audience. It is also deserving of notice that, though the lecturer takes the development of the Nautili and their allies as his principal illustration, he evidently attaches no weight to the argument in the opposite sense deduced by Barrande — the man of all others most profoundly acquainted with these animals—from the palæozoic cephalopods.

Another example is afforded by a lecture recently delivered at the Royal Institution in London by Professor Flower.† The subject is, "The Whales, Past and Present, and their Probable Origin." The latter point, as is well known, Gaudry has candidly given up. "We have questioned," he says, "these strange and gigantic sovereigns of the tertiary oceans as to their ancestors—they leave us without reply." Flower is bold enough to face this problem; and he does so in a fair and vigorous way, though limiting himself to the supposition of slow and gradual change. He gives up at once, as every anatomist must,

* Report in "Nature," June 21st, corrected by the author. † Reported in "Nature."

the idea of an origin from fishes or reptiles. He thinks the ancestors of the whales must have been quadrupedal mammals. He is obliged, for good reasons, to reject the seals and the otters, and turns to the ungulates, though here, also, the difficulties are formidable. Finally he has recourse to an imaginary ancestor, supposed to have haunted marshes and rivers of the mesozoic age and to have been intermediate between a hippopotamus and a dolphin, and omnivorous in diet. As this animal is altogether unknown to geology or zoölogy, and not much less difficult to account for than the whales themselves, he very properly adds, "Please to recollect, however, that this is a mere speculation." He trusts, however, that such speculations are "not without their use"; but this will depend upon whether or not they lead men's minds from the path of legitimate science into the quicksands of baseless conjecture.

Gaudry, in his recent work, "Enchainements du Monde Animal,"* though a strong advocate of evolution, is obliged in his final *résumé* to say: "Il ne laisse point percer le mystère qui entoure le developpement primitif des grandes classes du monde animal. Nul homme ne sait comment ont été formés les premiers individus de foraminifères, de polypes, d'étoiles de mer, de crinoides, etc. Les fossiles primaires ne nous ont pas encore fourni de preuves positives du passage des animaux d'une classe à ceux d'une autre classe."

Professor Williamson, of Manchester, in an address delivered in February last before the Royal Institution of Great Britain, after showing that the conifers, ferns, and lycopods of the palæozoic have no known ancestry, uses the significant words, "The time has not yet arrived for the appointment of a botanical king-at-arms and constructor of pedigrees."

Another caution which a paleontologist has occasion to give with regard to theories of life has reference to the tendency of biologists to infer that animals and plants were introduced under embryonic forms, and at first in few and imperfect species. Facts do not substantiate this. The first appearance of leading types of life is rarely embryonic. On the contrary, they often appear in highly perfect and specialized forms; often, however, of composite type, and expressing characters afterward so separated as to belong to higher groups. The trilobites of the Cambrian are some of them of few segments, and, so far, embryonic; but the greater part are many-segmented and very complex. The batrachians of the carboniferous present many characters higher than those of their modern successors, and now appropriated to the true reptiles. The reptiles of the Permian and trias usurped some of the prerogatives of the mammals. The ferns, lycopods, and equisetums of the Devonian and carboniferous were, to say the least, not inferior to their modern representatives. The shell-bearing cephalopods of the palæozoic would seem to have possessed

* Paris, 1883.

structures now special to a higher group, that of the cuttle-fishes. The bald and contemptuous negation of these facts by Haeckel and other biologists does not tend to give geologists much confidence in their dicta.

THE COLORS OF FLOWERS.

By AUGUST VOGEL.

WHEN we contemplate the extraordinary diversity of colors offered to us by the numberless flowers and fruits, ranging through all possible gradations from the purest white to the most intense black, we can do no less than admire so surprising a wealth of color-shades, and are naturally prompted to imagine that chemical processes influence their tone and effect the manifold changes. Although we are able to pursue the chemical processes occasioning changes of color in the mineral kingdom—we know, for instance, those occurring during the conversion of the white color of silver chloride into black—those in the living plant, whereby equally striking changes are effected, are unfortunately hidden from our scrutiny. For instance, we do not know the process which causes the immature fruit of the prune-tree to pass from the brightest of green, through the most varying gradations of color into light red, and finally deep dark blue; although we know that during the process of maturing the percentage of starch is by the aid of the vegetable acids of the fruit gradually converted into sugar, still, this phenomenon is not sufficient to throw light on so extraordinary an alteration of hues. To the operation of light is ascribed an essential influence in determining the vegetable colors; but that vegetable pigments can also be produced without light is shown by the yellow turnips, carrots, alkanet-roots and other roots, all of which develop their colors within the soil. Not only the light in general, but also its volume, appear to exert an influence upon the intensity of these pigments and their hues. This fact is confirmed by the intense and lively colors of flowers blossoming upon high mountains, and the increase of the flower pigment of the same species of plants with the augmenting elevation, with otherwise the same properties of soil and location. This increase of the pigments, such as is observed upon the Alps and other high mountains, stands most assuredly in connection with the stronger sun radiation at great height. It has further been proved that, under the influence of the almost uninterrupted duration of light during the short Scandinavian summer, many garden flowers of Central Europe gradually increase in intensity after having been acclimatized in Norway. Imported seeds of winter wheat, corn, peas, and beans, grow darker from year to year, until they have finally assumed the hue of native productions. Not alone do flowers, seeds,

fruits, and vegetables, become more aromatic in the northern latitudes, through the long constancy of light in summer, but their color also deepens, while the production of sugar decreases from the insufficient quantity of heat. Thorough experiments will reveal the effects of electric light upon vegetation, and we have no doubt that interesting results will be obtained in time, with regard to the influence of this light upon the pigment of flowers.

Our knowledge of the chemistry of vegetable pigments is not yet sufficiently advanced, for which reason the effect of artificial influence upon the color-tone of flowers has not yet received its merited attention. According to my view, tannin is an important factor in the generation of vegetable colors; it is found in almost every plant, the petals not excepted, and by the action of the most varying reagents—alkalies, earths, metallic salts, etc.—it assumes the most manifold hues from pale rose to deep black. A darker color, therefore, is produced in flowers rich in tannin, when manured with iron-salts, since, as everybody knows, tannin and iron-salts dye black, and produce ink. A practical use has been made of this fact in the raising of hortensias and dahlias. The former, which in ordinary soil blossomed pale-red, became sky-blue when transplanted into soil heavily manured with iron ochre, or when occasionally watered with a dilute alum solution. English gardeners succeeded in growing black dahlias by similar manipulations. It is well known to every florist that a change of location, that is, a change of light, temperature, and soil (replanting), occasionally produces new colors, whence it may be deduced that an interrupted nutrition of the flower may, under circumstances, effect a change of color. We see no valid reason why the well-authenticated fact of the change of color produced by manuring with iron oxide, thereby changing the nutrition of the plant, should not be practically employed by the hothouse gardener. Another very singular and successful experiment, in producing a change of color in a bird, has recently been made. A breeder of canary-birds conceived the idea of feeding a young bird with a mixture of steeped bread and finely pulverized red Cayenne pepper. Without injuring the bird, the pigment of the spice passed into the blood, and dyed its plumage deep red. The celebrated ornithologist Russ believes that the color of the plumage of birds might be altered according to desire, by using appropriate reagents.

Apart from chemical operations, there are also physical ones which, I believe, influence the color of flowers. It is a well-known fact that a most intimate relation exists between color and form. We know very well that the minute division of a pigment exerts a great influence upon its shade of color: a solid piece of vermilion does not possess the pale-red hue of the finely pulverized article; it is dark brown, and only shows a high red when scratched with a hard body, the color increasing with a continued comminution. Mercury oxide, while deep-red in a crystalline condition, becomes light orange-yellow upon con-

tinued pulverization. Deep dark-blue smalt can be converted into a perfectly colorless powder by being pulverized and washed, and no one would recognize it as being identical with the coarsely grained original article. Gold-powder, in its most minute division, does not possess the known yellow color of the metal, but a bluish-green shade, and at first glance would not be held to be metallic gold until the blue-green powder, when fused, reassumes its yellow color. When we introduce a film of gold between two transparent pieces of glass, and hold it against the sun, the rays of the latter will shine through with a bluish-green color; this transparency of gold, however, only occurs when the film is $\frac{1}{2000}$ of a line, or less, in thickness. It is indisputable that in the two instances mentioned here the appearance of color depends upon the minute mechanical division of the pigment, and with this is also connected the alteration in the color of solid bodies, when converted into gas or air. In a gaseous (therefore a very minutely divided) condition, black iodine becomes violet, yellow sulphur red, blue indigo purple. All these instances, to which numerous others might easily be added, prove the intimate connection between color and form. According to my opinion, some similar process, as far as regards form and division, possibly occurs in vegetable nature, and exerts its influence upon the multiplicity of color-shades.

Flower pigments, almost without an exception, are so inconstant and transient that they can not be employed in our industries. They, the children of light, separated from a vital union with the plant, no longer resist the effect of light—they wither and bleach in it. This is unhappily true with the most universally found of all—the leaf-green (chlorophyl). If this pigment could by some means be changed into a fast dye, the poisonous Swinefurt, or Paris-green, would have seen its last days. What an incomparable color is contained in the safflower (*Carthamus tinctorius*), which, although used as a beautiful rose in the dyeing of silk, is unhappily of an unstable nature! The same is true of the splendid yellow of the flowers of the wild *Reseda luteola*. This plant, in spite of the instability of its color, is cultivated in France, England, and different parts of Germany. The white color of various flowers—lilies, roses, and others—is generally produced by a white cellular juice, but may also be due to a white pigment, *antholeucine*, suspended in the colorless cell-juice. These white flowers would offer most suitable material for researches, if the experimental conversion of colors were undertaken. When undecomposed light is reflected by a body, its color appears to us as white. White, therefore, is no actual color, but simply a union of all colors, or the collective rays of light in an unseparated combination. By an alteration of the chemical combination in the plant, by means of an appropriate manure, it becomes possible to cause the fibers of the white petals no longer to reflect upon our eye an undivided white, but a divided colored ray. The yellow or orange coloring-matter of flowers, *anthoxan-*

thine, generally arises from the conversion of the chlorophyl. It occurs most frequently in the form of minute grains; sometimes also dissolved in the juice. Two anthoxanthines, therefore, must be distinguished in flowers—*xanthine*, which is not soluble in water, and *xantheine*, which is. The former dissolves with a gold-yellow color in alcohol and ether, is not affected by alkalies or dilute acids, but is colored green or deep indigo-blue by concentrated sulphuric acid. The soluble xantheine is by alkalies changed into brown. In the blue, violet, and red flowers (cornflower, hyacinth, violet, larkspur, sword-lily, rose, in the leaves of the red poppy, etc.), the pigment is found dissolved in the flower-juice almost without an exception. The red pigment of the rose, dahlia, peony, and other flowers, as well as that of violet flowers, is, according to recent observations, only a blue colored into red (anthocyanogen), by vegetable acids or acid salts. This is plainly proved by the acid reaction of the juice of red flowers, and the occasionally feeble alkaline reaction of blue petals, as I have universally found, with only a few exceptions.

When contemplating the boundless diversity of the hues of flowers, the very natural question involuntarily arises within us: For whom does the flower blossom in the solitude? For whom does it bloom in all its lavish beauty? No human eye beholds it, and yet it is arrayed in a pomp of hues unsurpassable in the dreary solitude, regardless of human applause. Nevertheless, we must not accept the unnoticed wealth of these manifold hues as due to accident; there is nothing accidental or superfluous in creating Nature, although we fail to perceive its purposes; Nature never wastes its energies in aimless, purposeless productions. As the song of the bird ceases when its plumage is adorned with lustrous, pronounced colors, so also are the colors of the odorous flower found to be more modest when compared with the scentless one, dazzling in the gorgeous brightness of its hues. This well-known, generally correct fact must not be treated as unworthy of consideration or due to accident. The firm belief of a definite, well-arranged connection of all earthly occurrences is deeply implanted within our breast. A well-defined law governs the varied hues of flowers, as offered us by the munificence of Nature, and it will, ere long, be revealed unto the eye of the student.

The truth of the celebrated saying of Justus von Liebig, "The knowledge of Nature is the path that leads us to the admiration of the Creator," is also verified here in the soundless laboratory of the colors of flowers.— *Westermann's Monatshefte.*

SKETCH OF DR. MAX VON PETTENKOFER.

"A CHAMPION against the Cholera" is the designation which Dr. Karl Stieler gives to the subject of this sketch, in his admirable biography of him in a former volume of "Daheim," to which we shall be largely indebted for such parts of our own article as are not mere date and detail. Since Dr. Stieler's article was written, Dr. Pettenkofer has distinguished himself by intelligent and thorough investigations in other forms of disease and in more extended fields of sanitary science, to the practical results of which it is impossible to attach too much value.

MAX VON PETTENKOFER was born December 3, 1818, at Lichtenheim, a quiet rural estate not far from Neuberg, on the Danube. When it came time to prepare for his life-career, he went to pursue his studies at Munich, where his uncle was court pharmacist, and there he occupied himself with such branches as were prescribed for students who intended to become physicians—branches which were sharply laid down in an inflexible course, for it at that time seemed a waste, says Dr. Stieler, to study anything that did not pertain to the class-examination. Happily, these studies were suited to the young man's taste; and, when he was graduated Doctor of Medicine in 1843, they pointed to the way which he had chosen. After graduation, led in that direction by Fuchs, he turned his attention to chemistry, and pursued that science, with physics, at Munich and Würzburg, and under Liebig at Giessen, steadily keeping his eye fixed on the relation of these branches to the healing art. In 1845 he was assistant in the chief office of the mint in Munich. In 1847, when not quite twenty-nine years old, he began his work as an academical teacher by accepting an appointment as extraordinary professor in the medical faculty at Munich. Six years later, in 1853, he became a regular professor, having in the mean time succeeded his uncle as director of the court pharmacy. Under his management this establishment became a real scientific laboratory. His first labors were predominantly technological, and related to the affinities of gold, the preparation of platinum, and the hydraulic lime of England and Germany. He also found a process for obtaining illuminating gases from wood, and investigated hæmatinon and aventurine glass. He made studies in oil-colors, in the course of which he discovered a valuable method of preserving oil-paintings.

The peculiar and most evident direction, however, in which his activity manifested itself was in the field of public hygiene, in which he has accomplished an extraordinary amount. His first important efforts in this region were his investigations of heating by stoves and by air, of the conditions of house-ventilation, of the influence of soil

upon health, and of the physical relations of clothing. In short, this new domain of knowledge opened itself to him on all sides. The conviction had grown up in Germany that the care a people takes for its public health may be regarded as an index of its advance in civilization. This care, he taught, concerns not only the healing of diseases, but even more the guarding against them; by the side of the care for the sick should stand a regard for the preservation of health, which should avail itself of the most recent results of science, and should be exercised by the state as one of its most pressing duties. That these views so made their way in Bavaria that professorships of hygiene, of which he was assigned to that in the University of Munich, were established in the high-schools of that kingdom, was mainly due to Pettenkofer; and the interest in hygienic matters, which was minifested in other ways, was excited chiefly by his motion.

Hygiene of course acquired an increased importance during epidemics, when disease threatened not individuals only, but whole cities and countries. With this category we enter upon the region which Pettenkofer has made the objective point of his activity. The investigations which he published on the nature and spread of the cholera enjoy an authority that is hardly limited by geographical boundaries. Here, indeed, Science has to contend with many unknown factors, and we should contradict the views of our active investigator himself if we should assume to speak of conclusive results. Nearly all in the present theories is provisory; the most varied points of view are opposed one to another; but, notwithstanding this, the beginnings that have been made, and the few fixed points that have been verified with respect to the questions, are a priceless gain. Hardly any other kind of affliction, observes Dr. Stieler, has been in the past so surrounded with superstitions as that of great epidemics. Thousands of persons were murdered in the middle ages on charges of poisoning wells; and, even after this kind of barbarism had disappeared, the terror remained which every danger excites, before which we stand ignorant and defenseless. We have now entered an age of correct discernment; intelligent investigation has taken the place of superstitious fear, and has neutralized its grievous effects by seeking and finding out natural causes. The ghostly element which seemed peculiar to these diseases has been destroyed, for it is no longer able, after the fashion of ghosts, to evade every attack, but has been made accessible and tangible, like every other enemy. Dr. Pettenkofer has had a great part in bringing about the revolution that has taken place, by taking hold of the ghosts, as it were, and compelling them to stand and receive his attacks; and, instead of resigning himself to their supposed machinations, he has taken the chief and leading part in contending against them. His researches have established, however much we may still contend respecting the ultimate origin of cholera, that three conditions appertain

to its outbreak in concrete cases, which may be designated as local, temporal, and that of the individual disposition. What we call the locality must have the infectious matter concealed within itself before persons abiding there are affected. Not every time is alike favorable to the infection; and, when place and time concur, only those persons are affected who offer a suitable personal disposition to the poison. Such persons, even in the worst cases, form hardly five per cent of the population. Thus, the spread of cholera is found to be governed by three factors, the operation of which can be comprehended by all. Further, Dr. Pettenkofer has taught that the danger of attack with cholera does not ordinarily come from persons who are sick, but primarily from the place, showing that the physicians are no more liable than others, and greatly relieving the duty of caring for the sick of its most formidable terrors. The rules respecting disinfection, the discovery of a term, not longer than fourteen days, to which the prevalence of cholera in a particular house is limited, and the prescription of the measures which every one should adopt in the matters of food and drink, clothing and cleanliness, are points of great value for the saving of lives, in which, says Dr. Stieler, Dr. Pettenkofer's determinations have been most definite. If any one makes the objection that these rules contain nothing particularly new, the answer is returned that modern medicine no longer deals in mysterious receipts, but is associated with the nearest and most diversified elements in our life, which not every one knows how to satisfy, or which are neglected because they are commonplace, every-day affairs. It appears now to be the chief purpose of hygiene to convince the masses that the commonest matters are the most important. No science can be less aristocratic, none has to be more intent on popularizing its results. In this popular spirit Dr. Pettenkofer prepared his treatises on "What we can do against the Cholera," and "The Present Condition of the Question of the Cholera." He was president of a cholera commission which met in Berlin at his suggestion, and was a member of the congress which met at Weimar in 1867, with similar objects. His investigations on the cholera, which were afterward extended to typhus and to the various sources of disease in the ground, the air, and the water, have given the impulse to the most comprehensive researches by hosts of inquirers. He constructed an apparatus for exact investigations in respiration, and undertook, in connection with Voit, a series of comprehensive labors on the respiration and nourishment of men and animals, through which many data were collected having an important bearing on the theory of metamorphoses of matter.

Dr. Pettenkofer's works have been published for the most part in professional journals. Since 1842 he has contributed numerous articles in chemistry and kindred subjects to "Büchner's Repertorium," "Dingler's Journal," and the "Denkschrift" of the Munich Academy of Sci-

ences. His principal independent works are "Untersuchungen und Beobachtungen über die Verbreitensart der Cholera" ("Researches and Observations on the Way in which Cholera is spread," Munich, 1855); "Hauptbericht über die Choleraepidemie von 1854 in Bayern" ("Principal Report on the Cholera Epidemic of 1854 in Bavaria," Munich, 1857); "Ueber den Luftwechsel in Wohngebaüden" ("On Change of Air in Dwelling-Houses," Brunswick, 1858); "Die Atmosphärische Luft in Wohngebaüden" ("Atmospheric Air in Dwelling-Houses," Brunswick, 1858); "Cholera regulativ von Griesinger, P. und Wunderlich" ("Cholera regulation, by Griesinger, P. and Wunderlich," Munich, 1866); "Ueber Oelfarbe und Konservirung der Gemälde" ("On Oil-Colors and the Preservation of Pictures," Brunswick, 1869, second edition, 1872); "Verbreitungsart der Cholera in Indien" ("How the Cholera is spread in India," Brunswick, 1871); "Zur Ætiologie des Typhus" ("To the Etiology of Typhus," Munich, 1872); "Beziehungen der Luft zur Kleidung, Wohnung und Boden" ("Relations of the Air to the Clothing, the Dwelling, and the Soil," third edition, Brunswick, 1876); "Ueber den Werth der Gesundheit für eine Stadt" ("On the Value of Health to a City," Brunswick, 1873); "Ueber den Gegenwärtigen Stand der Cholerafrage" ("On the Present Condition of the Cholera Question," Munich, 1873); "Künftige Prophylaxis gegen Cholera" ("Future Prophylaxis against Cholera," Munich, 1875). With Buhl, Radlkofer, and Voit, he has published since 1876 the "Zeitschrift für Biologie," or "Journal of Biology." Articles from him have been published in "The Popular Science Monthly" on the "Relations of the Air to our Clothing" (vol. x, p. 654); "Relation of the Air to our Houses" (vol. xi, p. 196); "Ground-Air in its Hygienic Relations" (vol. xi, p. 280); "Hygienic Influence of Plants" (vol. xii, p. 417); and the "Sanitary Relations of the Soil" (vol. xx, pp. 332, 468).

Dr. Pettenkofer is a member of long standing of the Academy of Sciences of Munich. In 1880 he received the Royal Order of the Crown.

CORRESPONDENCE.

BLACK REPLIES TO OSWALD.

Messrs. Editors:

DR. F. L. OSWALD'S answer in your last issue to my criticism demands a reply, for the purpose of elucidating who is in the right on questions closely appertaining to every one's welfare.

His personal allusions may be at once thrust aside as irrelevant. The reading public can not be interested in me, but presumably in my statements, whether they are true or false—not whether I am assuming, which I am not, to represent some forty thousand physicians of the so-called orthodox school.

Dr. Oswald antagonizes my statement that the tendency to dyspepsia is an inherited one, by a glittering generality. Can I "deny that from the moment of birth millions of infants are overfed and drug-poisoned"? Well, what of the millions that are not? Are they the ones who do not show any such tendency, despite the fact that some of their progenitors do? Let him produce his proofs, or hold his peace. Such an answer to overthrow an established doctrine, unless verification be produced of causal relation between the antecedents and consequents, is not worth the paper on which it is written. To illustrate: I can with equal plausibility deny that insanity is hereditary by the assumption that it arises *de novo* from a source whose reality Dr. Oswald can not deny, that millions of children are from the moment of birth overfed and then overtaxed by brain-work at school; or, in the example of consumption, that heredity has nothing to do with it, for are not millions overfed and lung-poisoned by impure air from the moment of birth? Such is the style of sophomoric inanity which assumes to overthrow the doctrine established by vital statistics and by the observation of all competent men, that all organic defects, whether inherited or slowly acquired, are transmissible qualities.

Dr. Oswald answers to his inconsistency of cleansing his outside skin with soap and water, and allowing his much-abused and betimes very filthy inside one—the alimentary mucous membrane—to cleanse itself, by the inquiry, "Does Nature ever protest against soap and water?" She does, as every practical physician well knows. Turn to any standard author on skin-diseases, and the use of any kind of soap will be found to be prohibited in some cases, especially in those whose cuticles, like homœopathic remedies, are far too tenuous. The striking benefit of a cleansing cathartic which men and women often feel, after having suffered for days from a dead, heavy, aching languor, is such a common realization that Dr. Oswald may save himself the trouble of elaborating a specious theory to prove them deluded, for facts are such stubborn things.

And this brings me to the silly slang characteristic of all kinds of quacks—their never-ending harping about "poison-drugs." It is their shibboleth, the great hope of gain to themselves by acting on the fears of the afflicted. What is a poison? It is any substance taken into the body which with more or less rapidity tends to destroy life. This embraces every substance except foods, air, and drink—from the clay eaten by the Brazilian, to the alcohol in the beer of the Teuton. Do a few grains of santonine, to expel lumbricoides from the bowels, tend to destroy life or to preserve it? Do a few ounces of alcohol, to tide failing vital power over a dangerous depression, tend to destroy life or to preserve it? Do a few doses of quinine, to arrest an ague-chill, tend to destroy life or to preserve it? Or, to put the query in another form, Do the effects of the santonine, the alcohol, and the quinine, tend to aggravate or to render the disorders for which they are given more dangerous? Even a Dr. Oswald, or a Dio Lewis, who contradicts the almost universal experience that they tend to preserve life instead of destroying it (that is, do not act as poisons), may be asked for the evidence to show that nearly all the world are wrong, and they only are right. If a few doses of quinine could produce profound and dangerous vital disturbances at all approaching those of the fever for which the medicine is given, then Dr. Oswald might have at least one string to his harp. If, after taking fifteen grains of quinine, he was seized with a severe chill—with burning fever, with aching misery in every bone and nerve of his body—with vomiting, with protracted debility and wasting of the body, and, after a few doses more, with a congestive chill, ending life in a few hours, then Dr. Oswald might with good reason take up the battle-cry of quackery, "Poison! poison!" Until Dr. Oswald proves that the quinine *does not* preserve from these very dangers to health and life, leaving no ill effects except those that belong to the disease—his *ipse dixit* about drug-poisoning is on the same level and has exactly the same value as the venal drivel of other quacks whose shibboleth he adopts. Let me say to him that enlightened therapeutists give medicines nearly always

on account of the fact that they can communicate certain kinds of energy to deranged functions, to modify, exalt, or depress—as may seem needful—in order to save life.

When a supercilious theorizer, a man who has not for a long series of years anxiously wrestled with the problem every day of his life how the sick can best be made well, thinks he can solve it far better than the tens of thousands who have so wrestled, one can only feel contempt for his inordinate vanity—to be merged into pity when he carries his bigotry about drug-poisoning so far as to leave Nature to war unaided with the putrescence of syphilis rather than take the potassium iodide. The outcome to such blood is its evolvement into extinction, as it deserves to be.

It is, Messrs. Editors, scarcely likely that one who had the privilege in his youth of sitting under the tutelage of such a master of organic chemistry as the late Professor Draper should not know the very elementary fact that digestion is a chemical process, or that he would fall into the blunder of a Dr. Oswald, who, in the last paragraph but one of his answer, writes of digestion and assimilation as being one and the same thing. But better things can not be expected of any one who quotes Dio Lewis, Graham—*et id genus omne*—as authorities in sanitary science, in place of Pettenkofer, Parkes, and Richardson. It is allowable to speak to the popular reader of a large meal as a load for the stomach, but it is presumable that Dr. Oswald, in his wrath at the application of a mechanical term to that process, is not acquainted with the views of some acute, recent philosophers, who think that all the phenomena of the universe can be explained on the laws of mechanics, from the motions of molecules up to those of the celestial masses.

Dr. Oswald asks, has observation not taught me that "the chronic hunger of the dyspeptic is as abnormal as the poison-thirst of the confirmed drunkard." Few things could more conspicuously display a man's ignorance of physiology and pathology than such a question. Not to enter into the several forms of dyspepsia, let me take the most common—a chronic deficiency of gastric juice to convert food into peptone. In such instances there is a dread of eating on account of suffering, with hunger because of the poverty of the blood and the gaunt wasting of the body from inanition. Yet the normal craving for food in a state of semi-starvation is held by our doctor as identical with the abnormal craving for alcohol by the diseased nervous system of the drunkard! The true remedy for the craving of the drunkard is complete abstinence from alcohol. Does Dr. Oswald, to carry out his parallel, recommend entire abstinence from food as a cure for the hunger of dyspepsia? Or would our astute M. D. prescribe a good large "drunk" once in twenty-four hours, even as he recommends one good large meal at a like interval for the dyspeptic? The ability to carry out the latter plan would take the tough *physique* of savages to endure, these being the order of men which he holds up for us to copy in our gastric performances. Dr. Oswald is apparently unable to discern that all the customs and habits of savages are intimately correlated to their vital organism, and that for us to adopt only one of them might prove murderous to civilized beings. For instance, among the sixty generations of barbarians of which he writes, all the weaklings were killed off in infancy by its perils; now, we nurse them up to adult life, and Dr. Oswald proposes to cure them of their weakness by the adoption of a savage habit—the one-meal-a-day system.

Perhaps Dr. Oswald will find that, in uttering a gratuitous insult in the closing sentence of his communication to that large body of medical men to whom alone is due the entire credit for all the great discoveries and improvements in anatomy, physiology, etiology, hygiene, pathology, surgery, gynæcology, materia medica, and practice, he has only succeeded in belittling and defiling himself.

J. R. Black.

MORE SUPPOSED PRE-GLACIAL HUMAN TRACKS.

Messrs. Editors:

I noticed in a recent issue of the "Monthly," a note in the "Miscellany," referring to the presentation of fossil remains of the primitive horse by Professor Leidy, that the remark was made by Professor H. C. Lewis that, while evidences of post-glacial man were frequent, it was not known that any scientific observations of pre-glacial man had been found either in Europe or America, etc., etc. I wish to bring to the notice of the scientific men of America and Europe an incident which occurred in the town of Chatham in this State, some six or seven years ago, and which seems to me to distinctly prove the existence of pre-glacial man more decidedly than anything else that has come under my observation.

The town of Chatham, as may be seen by reference to the map, lies at what has been termed the "elbow of Cape Cod." It is exposed to the full sweep of the waves from the broad Atlantic, which during the storms from the southeast beat upon its shores with tremendous force. It was during such a storm—the exact date of which I can not now state—that the bluff upon which stood the two light-houses, was rapidly undermined; the bluff here was, on an average, some forty or more feet in height, and, like all the rest of the cape, was com-

posed of drift. The lamps were removed from the two towers, and one of them soon after fell over; the previous morning they had stood nearly four hundred feet from the bank. The *detritus*, by the heavy pounding of the surf, was cleaned out, revealing the fact that the bottom, for half a mile along the line of coast, and more than one hundred yards landward, had been uncovered, and consisted of a hard blue clay, in which were imbedded many trunks of trees, and that the whole surface was covered with tracks of animals of different sizes and shapes; while, proceeding in a diagonal direction from the still-overhanging bluff, to the sea, were the perfectly preserved tracks of five pairs of naked human feet, evidently those of a woman and four children of different ages; three were upon one side of the woman and one upon the other. The tracks, as I have been assured by the most intelligent men of the place,* were as distinct and perfectly preserved in the clay bottom, as though made but the day before; they all had the same peculiarity noticed in those who live a free and unrestrained life—that the toes were not turned out, but that the step was straight forward. Around one stump, broken off several feet above the surface upon which these tracks appeared, were many confused tracks, and much hair.† From reports made me, I judge it must have been some animal of the deer or bison family, scratching himself upon the sharp, broken fragments of the stump. I sent some of the hair to the Secretary of the Museum of Natural History of Boston for a microscopical examination. Although quite a number of months have elapsed, no report has been made to me as yet of the result of it, although one was speedily promised at the time I sent it.

The question that appeals to the scientist for solution is, "When were these human foot-prints made?" It is one more easy to be asked than answered; yet it is plain to any observer that they could only have been made prior to the Drift epoch, which piled, by glacial action, over forty feet of stones and dirt above them. This deposit was made—or at least begun—suddenly. We see too many tracks to allow us to believe that this bottom could have been at the ancient sea, for then the tidal action and storms must have obliterated the impressions; for they were too numerous and of too diverse a character to permit the idea that they did not require a considerable period of time for their formation; the children were walking along by the side of their adult companion, without fear or hurry; close by where they passed, an animal "with feet as large as a big ox's, and the same shape," before or after they passed, relieved himself of his winter's growth of hair; for the hair was all of four or five inches long, and was trodden into the clay, and adhered to the stump in large quantities. There were also marks of feet showing a most perfect *fac-simile* to the bear of to-day—some form of *plantigrade*, surely; and they would not have taken the course they did had not the coast been clear. It was spring when this was covered by the drift, for this animal was not only getting rid of a heavy coat of hair, in immense quantities, but the woman and children were barefoot, conclusively proving that the weather, at the time these impressions were made, was moderately or quite warm, and that it was in the early spring; that a severe winter was the rule, by the length and great abundance of the hair rubbed off by this bison, moose, or elk, or whatever he might be; that the coast-line was lower than it now is, as proved by the growth of trees, which served the people living near the beach for fuel many weeks. But the great question of *when* all this took place, is one that I leave for others to answer. The fact that the whole of Barnstable County, commonly known as Cape Cod, shows, in all its parts, unmistakable proofs of long-continued glacial action, with large bowlders thickly planted in many localities; while, by boring for wells in nearly all parts of the town of Chatham, down to a depth of thirty feet or thereabout, evidences of the drift only are found, and then a stratum of blue clay to an unknown depth; and that this same clay is found all over the cape at varying distances from the surface—would mark it as the original pre-glacial bottom, and the impressions I have mentioned those of the true aboriginal inhabitants, belonging to the Pliocene period.

C. J. RICKER, M. D.

NEWTON, MASS., *May* 12, 1883.

* One of the principal gentlemen from whom the above information was derived is Captain George Eldredge, author of "Eldredge's Charts," "Eldredge's Coast Pilot," etc. Another is Levi Atwood, Esq., editor of the "Chatham Monitor." Both these gentlemen live in Chatham, and from long personal acquaintance I can speak highly of them as men of truth and general trustworthiness. Both they, and many others, equally reliable, will confirm all the facts I have stated above.

† Captain Eldredge told me he should judge that, were it all collected, there would be two quarts of it. He showed me some that he had gathered and preserved; it was coarse, reddish-brown, and about four inches in length, or varying from three and one half to four and one half inches long. It may be well to state that after a few storms the whole of the uncovered portion was covered once more with sand, and all these wonderful phenomena were obliterated. Under the bluff are yet concealed sights, perhaps still more useful to archæology.

HOMŒOPATHY AND QUACKERY.

Messrs. Editors:

IN the June number of "The Popular Science Monthly" is an article on "Quacks and Quackeries," which, in its allusion to

homœopathy, should not go unnoticed. The very fact of homœopathy being classed with quackeries is an insult to the nearly nine thousand physicians of that school in the United States, and their hundreds of thousands of patrons from the most intelligent and enlightened portion of the community. The writer of the article makes an utterly unfair and garbled presentation of our system of medicine, and some of his statements are absolutely false; as, for instance, he pretends to quote from an address delivered at the meeting of the American Institute of Homœopathy, held in Milwaukee in 1880. I have before me the proceedings of that meeting, and there is absolutely nothing, from the first page to the last, that could be even willfully distorted into such a statement as he makes regarding the progress of homœopathy. As for the legal recognition of homœopathy, let our fifty-four hospitals, our twelve fully-equipped colleges, our forty dispensaries, our medical departments in State universities, our insane asylums and hospitals under State and city patronage, speak for themselves.

As a reader of your excellent journal for many years, I protest against such treatment of a recognized system of medicine, and trust that you will permit a fair and just presentation of homœopathy to be made in the journal.

Respectfully yours,

H. R. STOUT, M.D.

JACKSONVILLE, FLA., *July* 2, 1883.

INTELLIGENCE SHOWN BY ELEPHANTS.

Messrs. Editors:

THE article on the "Mental Capacity of the Elephant," in the August number of "The Popular Science Monthly" was of much interest, and I beg to add a few more instances of the intelligence shown by these animals. In my childhood, when circuses or menageries exhibited near my home, it was my custom to rise early the next morning and feed the elephants with biscuit and grass. On one occasion, an elephant seemed to be trying to attract my attention, and when I approached he began moving the end of his trunk over the surface of his body, as if to rub himself, but not touching it. It was his method of begging in pantomime for a piece of wood. I picked up a piece of the thin end of a shingle, about the size of a page of "The Popular Science Monthly," and gave it to the elephant, so that he would be obliged to take it on the side, thinking that he would break it when it was put to use. To my surprise, after looking at the piece of shingle, he dropped it and picked it up by the end, and scratched himself, without breaking it. It has always seemed to me that this act of pantomime, and subsequent use of a piece of wood in the direction of maximum strength, involved a higher degree of animal intelligence than I ever saw exhibited elsewhere.

I attended Forepaugh's circus at Brockton, Massachusetts, on the 8th of last June, and I recollect seeing other feats than those cited by Mr. Hornaday, such as tilting on a see-saw, sitting with the fore-legs straight, "like a cat," and then saluting with the trunk; also dancing in various steps. But, shortly after the afternoon performance, two of the elephants were called upon to perform a task requiring more intelligence than any of the conventional ring feats. The facts are given in the following extract from the Boston "Herald" of June 10th:

The incident referred to took place on the fair-grounds at Brockton, where Mr. Forepaugh's show was exhibiting. Shortly after the *matinée* performance had concluded, a one-story frame building, used as a police-station, caught fire, and in a few moments the entire building was enveloped in flames. Attached to the station-house was a row of horse-sheds, and connecting with the latter was the grand stand, in close proximity to which were Mr. Forepaugh's tents. There being no fire appliances on the grounds, it may well be assumed that the burning building gave serious alarm to the circus-people, as well as to the citizens, many of whom had not yet left the grounds. At this juncture, Mr. Forepaugh and his general manager, C. W. Fuller, appeared on the scene. It was plainly apparent that, unless the horse-sheds were torn down, the grand stand would burn, and, in that event, the destruction of the circus-tents was inevitable. While all were excited and making futile attempts to pull down the building with their hands, Adam Forepaugh, Jr., came running up, and, taking in the situation at a glance, called his colored assistant and hastened to the elephant quarters, soon after appearing with Bolivar and Basil, the latter being next to the former in point of size. The two huge beasts were hurried over to the fire, and, much to the surprise of the spectators, began pulling down the horse-sheds, in obedience to the direction of the junior Forepaugh. The by-standers removed the *débris* as fast as it accumulated under the mighty blows of the elephantine firemen, who seemingly looked upon the affair as a matter of little moment. In an incredibly short space of time the horse-sheds were demolished, the grand stand was saved, and the circus-tents loomed up as proudly as ever.

C. J. H. W.

BOSTON, *August* 1, 1883.

ASSOCIATION OF COLORS WITH SOUNDS.

Messrs. Editors:

IN the August number of your "Monthly" you present a translation of a notice on the "Association of Colors with Sounds." The phenomena in question occur also in the sphere of other senses. Two Zurich students * notice association of sounds with lights: e. g., to one subject the full moon looked at through a red glass brings up the sound of an *l* joined to an *o*. Tastes, smells, even the shapes of bodies, pains, warmth, and cold arouse color visualizations in some subjects. All these are far less common

* Bleuler and Lehmann, "Zwangsmässige Lichtempfindung durch Schall," etc., Leipsic, 1881.

than "color-hearing," and more vague as well as individualistic. While in some instances the "photism," or associated color, is distinct for every note in the octave, and even for the overtones, in the associations with sounds, those with tastes, smells, etc., are barely more distinct than that fine, pleasant tastes and smells suggest bright colors, and contrariwise.

There seems to be an appropriateness in these general associations somewhat as we find in such expressions as a "*sweet* child." No one, I venture to say, if asked to associate colors with sounds, would make light colors correspond to low notes. More than this: Bleuler and Lehmann give a table of the number of cases in which certain colors are the "photisms" for the different vowel-sounds. On asking several persons to force themselves to make similar associations, I was surprised to find how well their answers agreed with the table. The answers were sometimes given with great reluctance, and, when evidently little more than guess-work, often disagreed with the tables.*

In the case of musical notes, tastes, smells, etc., the association seems to be effected by the "*sensational* element chiefly, if not entirely," in the vowel associations, and still more, in those with words, an "*intellectual* element seems to play a part." The sight as well as the sound of some letters and words brings up the "photism." We all know that some words have a *character;* words alike in meaning, the one of Latin, the other of Anglo-Saxon origin, often differ more in *character* than in anything else. In some cases it seems to be the *character* that forms the ground of association.

We find also visualizations of numbers; by some they are seen rising in a scale up to ten or twelve, and then breaking off, by others going around the body, and in one case even moral character and sex are attributed to them. These associations seem to be taken out of the sphere of the senses into that of the intellect. It is to be noticed that the *intellectual* associations are more individualistic than the *sensational* ones. The "photism" of the same *tone* is probably similar in two persons; if the same word, probably entirely different.

Of 596 persons (383 males, 213 females) examined, 76 cases were found, i. e., about 12¼ per cent. Slightly more (proportionately) cases were found in females than in males. The young seem to be subject to these visualizations rather than the old; the educated than the uneducated. The tendency to these phenomena seems to be hereditary.

There are many interesting and curious facts to be noted in these phenomena; the time for their explanation has not yet come. The method that seems most promising is that of careful compilation and judicious comparison of individual cases; and I take the liberty of adding that I would be very much indebted to your readers for any reports of similar phenomena observed in themselves or others. JOSEPH JASTROW.

GERMANTOWN (PHILADELPHIA, PA.),
August 1, 1888.

* In one case the answer to the call for an association with *o* was "*orange*, but it may be because that begins with an *o*." Bleuler and Lehmann give an exactly similar case when the color was visualized. Even more accidental circumstances than this form the ground of such associations. I found one person to whom Sunday always calls up the color blue (similar cases are reported by the Zurich students), and who traces the circumstance to his having worn a blue frock on Sundays in early childhood.

EDITOR'S TABLE.

THE MINNEAPOLIS MEETING.

WE are gratified in being able to report that the recent meeting of the American Association for the Advancement of Science, held this year at Minneapolis, was most satisfactory and successful. It was, of course, not so large as it would have been if convened in a more central and accessible place, but we have attended smaller gatherings of this body a good deal nearer the seaboard. About three hundred members were in attendance, which, considering the obstacle of distance to be overcome by many of them, shows that there is a strong and well-sustained interest in the work of the Association. But the success of such a meeting is by no means dependent upon the extent of the congregated membership, for it may be assumed that those present were mainly selected by the earnestness of their interest in the objects of the organization. A successful scientific meeting, so remote from the great centers of population, is the best test of the vigor and prosperity of the body. No doubt it is desirable that it should most frequently meet

at points of average accessibility; but, as the policy of the Association embraces the whole country in the sphere of its influence, and as it is designed, at least partially, to encourage the popular interest in science by visiting successively all the leading cities, it is well that outlying places should not be habitually neglected. The strangers were welcomed with the most hospitable entertainment by the citizens of Minneapolis, and everything was done to make their visit agreeable.

The work of the American Association on this occasion was excellent on the whole, and does not suffer by comparison with that of previous gatherings. There was a large list of papers of quite average merit, and some of them of unusual interest. Able addresses were delivered by the chairmen of the sections, and the one by Professor Rowland, of Johns Hopkins University, before the Section of Physics, we hope to give our readers in the next number of the "Monthly." The retiring president, Principal Dawson, of Montreal, gave an able address on "Some Unsolved Problems in Geology," the first part of which will be found in our columns this month. It is mainly devoted to a discussion of the evolution hypothesis, of which Dr. Dawson can not be claimed as an adherent, and he improved the occasion to give a forcible exposition of its difficulties from the geological point of view. It is undeniable that these difficulties are many and formidable, and it will, no doubt, take a long time to clear them up, while the solution of still unresolved problems will very possibly result in important modifications of the theory as now entertained. But the establishment of the doctrine of evolution as a comprehensive law of nature is no longer dependent upon its freedom from embarrassments or that absolute completeness of proof which will only become possible with the future extension of knowledge. Notwithstanding these drawbacks, the evidence for it is so varied, so consistent, and so irresistible, as to compel its broad acceptance by men of science, who, while disagreeing upon many of its questions, acknowledge that it is now indispensable as a guide to the most multifarious investigations. It is gratifying to observe that the spirit of passion, dogmatism, and prejudice, which has been so rife in connection with this discussion during the past generation, is measurably subsiding, and that the controverted questions that remain are considered with increasing calmness, candor, and loyalty to truth.

CONCERNING QUACKERY.

Some offense has been taken at parts of Dr. Shepherd's article on "Medical Quacks and Quackeries," which appeared in our June issue. The writer ranked homœopathy as a form of quackery, and cited certain of the dogmas of Hahnemann, founder of the school, in justification of his charge. "The Popular Science Monthly" is censured for lending the weight of its authority to this accusation, and we have received sundry replies to Dr. Shepherd's strictures, of various merit, one of which, from an eminent source, is herewith printed.

It seems hardly correct to charge the "Monthly" with lending its influence to partisan objects in this matter, because the expression of an opinion on the part of a contributor by no means commits the magazine to it. Many periodicals advertise that the editors do not hold themselves responsible for the views of their writers: we have not done this, because it seemed superfluous. We often print statements with which we do not agree, and sometimes express dissent; but it by no means follows that a failure to protest is to be construed into an indorsement of all that appears in our pages; while certainly no one would expect that we should limit ourselves to printing only

that which perfectly accords with our own notions. That we are not partisans in this matter should have been inferred from our frequent habit of giving replies to one-sided statements, as is done in the present number, and also from the fact that we have published sharp reflections upon the regular school of medicine. The article entitled "Quackery within the Profession," which appeared in the March number of the "Monthly" of last year, sufficiently attests this: it was an unsparing denunciation of the quackish tendencies that are growing up within the limits of the old orthodox medical school.

We are much inclined to accept the view taken in that article, which is that "*systems* and *cures* of any class or description" adopted by any school of medicine are of the nature of quackery. We agree with the writer when he says: "There is no system, or cure, or charm, or nostrum, known to the profession; our calling consists solely in the rational study and treatment of disease on common-sense principles." Whether a valid "system" of practical medicine will ever become possible is doubtful, but it is sufficiently certain that the present state of science does not warrant it; and, in this condition of things, any one method of cure to be generally followed must be misleading and injurious. Yet, to the mass of the people, there is something fascinating in a medical theory that can be put into a neat and simple formula. And the effect of this is more pernicious in proportion as these formulas are made the rallying-cries of the different schools of medical practice. These schools are candidates for popular favor. The patronage of the physician comes from the people; the people are ignorant and prejudiced, and easily taken by catchwords and clap-trap; while the doctors, as a class, are sufficiently human to avail themselves more or less of this state of facts in the way of business. The tendency of practitioners is to magnify the differences among the several 'pathies, and thus to favor the notion that some one of them contains the fundamental truth, while all others are essentially erroneous, and, as the people are generally educated to identify themselves with sects and parties, they are well prepared to become partisans in the matter of medical treatment. Thus doctors and laymen react upon each other to strengthen injurious prejudices. As Dr. R. O. Beard remarked, in an article upon "The Schools of Medicine," which we printed last February: "Rooted in the professional ignorance and bigotry of almost a century ago, fostered by the bitter rivalries and exclusivism of opposing theorists, these differences have been taken up and fed by popular opinion, until they seriously embarrass the progress of medical knowledge, and tend to destroy all faith in the science and art of healing. The medical fraternity at large, and of both schools alike, is responsible for this unfortunate condition of affairs. When professional men, who, supposably, represent the best phases of liberal thought and scientific culture, lend their names to the partisanship of mere theory, and array themselves under sectarian titles which signify their adherence to an exclusive dogma, it is small wonder that the laity should follow in their footsteps, and cast their views into the yet narrower mold of unreasoning prejudice."

The fact is, medical practice is far in advance of medical theory. Physicians can do a good deal more than they can explain. The advice of the old judge to the young judge—"Refrain from too much expounding, for you will generally be right in your decisions and wrong in your reasons for them"—is not without its bearing upon the medical profession. Medical philosophizing may be well, but it must be kept within limits, or it will certainly mislead in practice. The doctor who

has a hobby in which he profoundly believes will be dangerous in the sick-room. The most important revolution in medicine that has ever taken place is that modern change of view by which the practitioner leaves more and more to nature in the conduct of his art and, as a consequence, assigns an ever-increasing value to hygienic considerations.

In regard to homœopathy, there can be little doubt that its practical influence has very much coincided with the inevitable modern tendency to abandon heroic treatment, and give nature a better chance. But homœopathic theory is quite another thing. Dr. Bayard, in the paper we publish, written to vindicate its claims, says that "homœopathy, as a science, is the law of the vital force"; and, again, "disease is the impairment of the equalization of the vital force." But the most advanced scientific thinkers are seriously asking, Is there any such thing as the vital force? or, if there be such a thing, what is it? Certainly it is a something which played a far larger part in medicine when the scientific knowledge of life was in its lowest condition. Everything in the organic economy not understood was then ascribed to "the vital force." Every step of physiological progress has consisted in wresting something from "the vital force," and explaining it in some intelligible way. As physiological problems have been resolved by physical and chemical principles, and taken their place among the proved results of science, "the vital force" is no longer invoked to account for them. Its sphere has, therefore, been gradually restricted, and its intrenchment is still in the narrowing field of physiological mystery. To ascribe an effect to "the vital force" is now but another way of saying that we do not understand its cause. How the mysterious and the inexplicable can become the basis of a special and distinctive science is itself something of a mystery. The article of Mr. Shipman on "Matter Living and Not-Living" will be read with interest in connection with that of Dr. Bayard.

LITERARY NOTICES.

SPENCER'S DESCRIPTIVE SOCIOLOGY: A CYCLOPÆDIA OF SOCIAL FACTS, representing the Constitution of Every Type and Grade of Human Society, Past and Present, Stationary and Progressive. In Eight Parts, large folio. D. Appleton & Co. Price, $35.

WE have from time to time made reference to this great work as its parts have successively appeared during the last fifteen years; but, having now assumed its completed or final form, we desire to call attention to it as a whole, and calculated to meet the wants of modern students in the way of a valuable work of reference.

As we have repeatedly explained, this comprehensive cyclopædia of social data is novel in form, the whole work being planned and executed with a view to the utmost facility in getting at the multitudinous facts which it records. Mr. Spencer had before him a task of great difficulty when he attempted to present the materials that are descriptive of all phases of human society within an available compass, and by a plan that shall make them in the highest degree accessible for reference, and at the same time instructive for comparative study. After long reflection and various trials, he was compelled to adopt the tabular mode of arranging the facts, which necessitated the folio form of publication, with very large pages. This, of course, was undesirable, but it was unavoidable; yet, as the work is one rather for consultation than for continuous reading, there is really an immense gain in the plan chosen by which any one of its multifarious subjects may be followed out in its broadest relations with ease and dispatch.

Of course, the first thing Mr. Spencer had to do was to arrive at a classification of those elements and activities of human society which are the objects of study by the sociologist. These elements and factors exist in nearly every human society, but with the widest differences of form and development. In low and rude communi-

ties, the parts that make up the social state are rudimental, while in the ascending grade of social progress they are developed to all degrees of complexity. Some societies, as the savages, are stationary, that is, without historic change, and the descriptions of their composition and character are therefore simple, and occupy the least space. But other communities have had a long historical development, which has, of course, consisted in the evolution of the constituent parts, and these have therefore to be separately traced through all the stages of progress.

To understand how difficult the mode of presentation was, we have but to refer to the extent of the subjects dealt with. Among the social structures and activities, are the forms of government, both general and local; industrial, educational, and military institutions; domestic relations, and the constitution of families; religious systems and ideas, and ecclesiastical organizations; ceremonial customs, and social habits; recreations and amusements; useful arts, inventions, industries, and the progress and condition of knowledge; moral sentiments, ideals, and practices, and the cultivation of taste and æsthetic art; the physical, intellectual, and emotional characters of different peoples and races; and the widely varied conditions of nature, and the environing circumstances that influence the social state. These are the fundamental facts of all communities which are to be inquired into by the student of social science, and Mr. Spencer's problem was to bring these facts into such relation by classification and tabular representation as will facilitate comparison for scientific purposes. It was indispensable that two conditions be fulfilled: In the first place, the facts required to be so presented as to bring out coexisting conditions, or to show how the various factors were combined and correlated in the social structure at any one period. In the next place, it was imperative that the movement of progressive societies from epoch to epoch should be so exhibited that each constituent should be separately traced, while at the same time the consensus of advancement is displayed. Progressive societies grow unequally. Some advance rapidly in certain lines, and slowly or not at all in others, and to deduce the laws of social growth, the first condition is that of comprehensive comparative study, and Spencer's cyclopædia is conformed throughout to the attainment of this object.

It will be seen that in the nature of the case the work must have been on a very comprehensive scale. A treatise for this purpose within moderate limits would have been good for nothing; and the treatment of the subject in the ordinary form of books would have been of but very little service. But, by getting rid of all that is superfluous, by eliminating irrelevant statements, and rejecting comment and speculation, in short, by confining the digest to the essential things concerning human society to which science must be confined in its work of estabishing general truths, it became possible to condense immense amounts of historic and descriptive matter within comparatively narrow spaces. It is the merit of Spencer's work to have accomplished this object with remarkable success. Of course, anything like a really universal description of human societies, no matter how condensed, would be practically impossible, nor would it be at all necessary. What is wanted for general instruction, and scientific induction, is an array of social data that shall largely represent all the types, forms, and grades of the social state. The greatest number of human societies upon the earth are still in the low and comparatively stationary condition, although in this respect no two are alike. A large number must therefore be studied, sufficient for the derivation of general principles, but it would be needless to extend the list to unmanageable proportions. Then there are societies which have advanced to certain stages of civilization where they have been arrested and fallen into decay. A sufficient number of these require to be represented to teach the lessons they are calculated to enforce. Then there are societies which illustrate a long and slow historic progress through many centuries, and which stand at the head of the present civilization of the world. These are selected for the study of social development in its highest degree as hitherto attained. Mr. Spencer's work covers this broad field, and is thus fully adequate for the scientific demands of the

age in pursuing comprehensive sociological inquiries.

So large and laborious was the undertaking upon which he engaged and so difficult was it to command capable assistance in carrying out the project, so heavy the expense of the undertaking, both in securing the protracted services of capable assistants and in the publication of the works, which Mr. Spencer had to meet alone, and so intensely was Mr. Spencer himself absorbed in the execution of his elaborate system of philosophy, that the "Descriptive Sociology" proceeded slowly, and was published irregularly as the parts were successively brought to completion. They therefore appear in an order that was determined by the circumstances of their preparation. Of all the savage races upon the globe, the very lowest are the Negritto tribes and the Malayo-Polynesian races. These are dealt with in Part III of the cyclopædia. Seventeen examples are given as types of the lowest races, viz.: the Fuegians, Andamanese, Veddahs, Australians, Tasmanians, New Caledonians, New Guinea people, Fijians, Sandwich Islanders, Tahitians, Tongans, Samoans, New Zealanders, Dyaks, Javans, Sumatrans, Malagasy. Part IV is devoted to thirteen of the representative African races; Part V to fifteen of the Asiatic races; and Part VI to seventeen of the principal American races. These four parts exemplify the undeveloped, or the but rudely developed forms of social life which are to be taken as starting-points in studying the development of mankind. Part II is devoted to more advanced forms of society, the imperfect civilizations of which are decayed or extinct, and it embraces the Mexicans, the Central Americans, the Chibchas, and the Peruvians. This line of study is also still further pursued in Part VII, which delineates the social life and the form of civilization attained by the Hebrews and the Phœnicians. Part I and Part VIII, the first and last issued, are devoted to the sociological history of the English and the French as old historic and still flourishing civilizations. There is a more or less continuous social history of England and France, running through some two thousand years and culminating in their present high development, which makes them the best examples for tracing the slow-working agencies by which the highest social conditions have been attained. The sociology of the French is the most elaborately worked out of all, the part devoted to it being so large as to rank it as a double number.

It was Mr. Spencer's original intention to include some other societies in his project, but, as its execution threatened to become pecuniarily ruinous, he closed the undertaking with Part VIII. But the scholarship of the world owes him its best thanks for having carried this great, original, and invaluable work to such satisfactory completion as it has actually attained. The history of the advance of knowledge hardly furnishes a parallel to this enterprise. Mr. Spencer foresaw many years ago that the establishment upon a sound and permanent basis of the highest and most important of all the sciences, that of human society, would depend upon such a collection and systematization of its immense data as had never been attempted or even dreamed of by inquirers upon social subjects. All science rests upon the foundation of observed facts, and these facts must be as extensive as the generalizations to be built upon them. And, because such data were neither at hand nor forthcoming, nor deemed possible of procurement, it was held that sociology could never become a legitimate and well-grounded science. It might be a region of speculation, but it could have no valid inductive basis. Mr. Spencer perceived that there was no reason in the necessity of things for this hopeless conclusion, and he accordingly undertook the preliminary work of preparing a solid foundation for the new science. Nor is it too much to say that the issue of the first part of the "Descriptive Sociology" settled the question. So eminent an authority upon this class of subjects as Mr. E. B. Tylor, author of the "Early History of Mankind," remarked upon its appearance, "It is a sufficient answer to all disbelievers in the possibility of a science of history."

That this great work should not have been appreciated by the age to which it was offered is not surprising. The sciences that have been long established are still struggling for educational recognition, and no form of intellectual labor is so ill appreciated in these times and especially in this country as that which aims at the extension

of knowledge and the establishment of new truth. But this state of things can not last. Science is destined to make its way, and the science which furnishes a new method and new aids in the study of human affairs is bound to force the recognition that has not yet been accorded. There are many gropers in the field of so-called "Social Science," and, although their results are of but little value, they attest a vague belief in the social order as something capable of rational elucidation. What we want is better methods of conducting the investigation and a truer spirit of science in their pursuit. The work here noticed, in proportion as it becomes known, is certain to be tributary in an eminent degree to this desirable end.

REPORT ON THE THERMAL SPRINGS OF THE YELLOWSTONE NATIONAL PARK. By A. C. PEALE. Author's edition. Washington. Pp. 454, with Plates and Charts.

THE report is a Part extracted from the report of Dr. Hayden's "Geological and Geographical Survey of the Territories for 1878," and well deserves the distinction of a separate publication. It gives full accounts of all the geysers and hot springs of the park, arranged in the order of the river systems to which they belong, with the history of our knowledge of them, and of the region as a whole, accompanied by illustrations tinted in the natural colors, and maps, in which each spring and phenomenon described is indicated by a corresponding number. The reader of the historical introduction will be surprised to learn how short a time these wonders, now familiar and world-renowned, have been known. John Coulter, of Lewis and Clark's expedition, was the first man who ever saw them, and his accounts of them, first given in 1810, were not believed at all. James Bridger next told of them, in 1844, and was likewise discredited. Even the newspapers were afraid to publish any of his stories. Captain John Mullan, in 1853, heard something about the hot springs and geysers from the Indians; and Captain Reynolds, in a report to the Fortieth Congress, admitted that Bridger might possibly have seen such springs as he described. The first authentic description of the springs was published by David E. Folsom in the "Lakeside Monthly," Chicago, in 1870. Other explorations were made at about this time, and other magazine articles, some of them illustrated, were published concerning the phenomena; and the first scientific accounts of the region were given by the geological surveys of 1871 and 1872.

THE DISEASES OF THE LIVER, WITH AND WITHOUT JAUNDICE. By GEORGE HARLEY, M. D., F. R. S. Philadelphia: P. Blakiston, Son & Co. Pp. 751. Price, $5.

THE author published in 1863 a monograph on "Jaundice," with observations on the special application of pathological chemistry to the detection and treatment of diseases of the liver and pancreas. With the fruit of twenty years of additional experience, he has again gone over the subject and produced the present treatise, which, although it embodies the whole substance of the original monograph, "bears no more resemblance to it than a mature adult does to the suckling from which he sprung." While the scientific principles on which both works are founded are identical, the present one is much larger than the former, and contains in a condensed form a considerable amount of clinical and scientific data that have never before been collected into one volume. As in other branches of science, many old theories have been abandoned. The work being intended for the use of the "qualified brethren" of the author, he does not undertake to discuss them, but, in order that the reader may see how many of them have been given up and how many new ones espoused, he has put his own views, in accordance with the facts and arguments expressed throughout the volume, into a concise and diagrammatic tabular form.

"BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY." Vol. I, No. 4. New York: Printed for the Museum. Pp. 40, with Plates.

THE present number of the "Bulletin" is wholly occupied with a contribution by Joseph B. Holder on "The Atlantic Right Whales," in which he maintains that the black whale so called of the temperate Atlantic, which was lately introduced to science as a recent discovery, and is now after a long period of nearly total extinction rapidly increasing in numbers, "is the one

which our forefathers found abundant along the Atlantic coast, from Newfoundland to Florida. It is the one which was first hunted by the Cape Cod and Nantucket whalers; and is not the one now and latterly captured in the Arctic seas." Facilities have been given for the study of the animal by the existence of five skeletons in America and Europe, and by the capture of an adult specimen in 1882 off the New Jersey coast. To the results of the author's studies of the American specimens are added criticisms of previous accounts of the right whale, and a summary of historical mentions relating to the present and allied species. Some of Dr. Holder's conclusions have been disputed by Mr. J. A. Allen.

SAXON TITHING-MEN IN AMERICA. By HERBERT B. ADAMS, Ph. D. Baltimore: Johns Hopkins University ("Studies in Historical and Political Science"). Pp. 23. Price, 25 cents.

THE tithing-man's duties in Massachusetts and Plymouth colonies were very much like those of the constable, and, though he was preceded by officers of that name in New England, he was a far more ancient officer than the constable in the old country. While the constable had the care of public order, the tithing-man's duties were rather connected with the preservation of order and morals in families. Originally one was appointed for every ten families. Dr. Adams follows his account of the functions of the New England tithing-man with a review of the history of the office, which he traces back to the Saxon rule in England.

MEDICAL ECONOMY DURING THE MIDDLE AGES. By GEORGE F. FORT. New York: J. W. Bouton. Pp. 488.

THE author styles his work "A Contribution to the History of European Morals, from the Time of the Roman Empire to the Close of the Fourteenth Century." Its general purpose is stated to be that of an historical inquiry into the practical effect upon social life throughout the period traversed, of that singular credence which involved preternatural agencies. This belief appears to have been particularly general and controlling in respect to matters appertaining to the preservation and restoration of bodily vigor. Superstition seems to have reigned supreme down to the time of Charlemagne. From that epoch the slow growth of better ideas and a more intelligent practice may be traced, beginning with the schools fostered by that enlightened ruler, and the scholars he called around him. The scope of Mr. Fort's work includes the condition of medical art under the Roman emperors to Galen's time; the influence of the Alexandrine schools in producing a regular system of magic cures, and the progress of the magic system as a moralistic episode of the middle ages, concurrent with ancient medical text-books in the cloisters; the gradual development of the science, aided by Arabic erudition at the Italian universities; and the bloom of alchemy and astrology. Among special features receiving attention are the curative powers ascribed to gems, incantations, etc., the manner of dealing with abandoned women, and the status of physicians, of both sexes, at different epochs.

A DICTIONARY OF PRACTICAL MEDICINE. By Various Writers, edited by RICHARD QUAIN, M. D., F. R. S. Fourth edition. New York: D. Appleton & Co. In one large 8vo vol. By 1,834, with 138 illustrations. Price, $8.

THIS work, which has engaged the editorial labors of Dr. Quain for several years, is a single octavo volume of some eighteen hundred pages. No dictionary of medicine so compendious, and at the same time so authoritative, has yet appeared in any language. One hundred and sixty writers contribute an immense number of articles, varying in length from a column or less to thirty pages. Each contributor "volunteered or was invited to write on a subject with which he was specially familiar"; and the list of authors is as representative of the best literature of the profession in England, Ireland, and Scotland, as any that could have been framed. If the name of a distinguished authority is missed here and there, this is only the inevitable result of there being other and sometimes younger men, equally qualified and more conveniently situated for the particular purpose. Dr. Quain's editorial resources have been, indeed, of the amplest kind; he has marshaled an array of professional talent which is not only creditable to the position of the editor among his colleagues, but creditable like-

wise to the profession as a whole. Those who know nothing of dictionary-editing will hardly appreciate the editorial labor that this work represents. A sense of proportion in assigning the space to the several subjects in a vast field of knowledge must be constantly and watchfully observed, along with a due consideration for the value of everything that a distinguished contributor would wish to write on his favorite theme. It is given only to a firm hand and a delicate tact to achieve success in such an enterprise; and the measure of Dr. Quain's success must be, on the one hand, the compact form and size of his dictionary, and, on the other, the endless variety of the articles and the value of the signatures that they bear. An encyclopedic undertaking of this compass and quality brings to light both the wealth of our home resources in the particular learned profession, as well as the distinctively English characteristics of brevity and point. The new "Dictionary of Medicine" will take rank with the corresponding works in other departments of knowledge, for which the English press has acquired a certain distinction abroad; and it does not surprise one to hear that steps are being taken to have it translated into more than one Continental language.

The work is primarily a dictionary of practical medicine for the use of practitioners. It includes naturally all the diseases that come more particularly within the province of the physician as distinguished from that of the surgeon; but in the numerous articles on general pathology, general therapeutics, hygiene, medical jurisprudence, diseases peculiar to women and children, and subjects on the border-land of medicine and surgery, it includes all but the most technical parts of surgery also. It is, therefore, a work in which the general practitioner of medicine will find articles, in alphabetical order, on all the subjects that are likely to come under his notice in the course of his every-day work. The direct interest of it for the laity—the interest of the subject-matter, if not of the volume itself—is proved by the liberal allowance of space given to many matters that are a concern to all educated persons. Chief among the articles of this class are those on "Nursing the Sick and the Training of Nurses" (Miss Nightingale), "Administration of Hospitals, and the Construction of Hospitals" (Captain Douglas Galton), "Public Health" (the late Dr. Parkes), "Vaccination" (the late Dr. Seaton), "Contagion" (Mr. Simon), "Personal Health" (Dr. Southey), and "Predisposition to Disease" (Dr. W. B. Carpenter). Shorter signed articles of general interest are those on "Diet," "Climate," "Health Resorts," "Mineral Waters," "Sea-Air," "Sea-Baths," "Sea-Voyages," "Sea-Sickness," "Baths," "Douche," "Hydrotherapeutics," "Exercise," "Fatigue," "Effects of Extreme Cold and Extreme Heat," "Sunstroke," "Malaria," "Periodicity in Disease," "Epidemics," "Plague," "Quarantine," "Disinfection," "Mortality," "Alcohol and Alcoholism," "Criminal Irresponsibility," "Civil-Incapacity," and many more.

Many of the subjects of that class were, of course, ably handled by the older writers; and, more particularly, diet, climate, sea-voyages, and the like, were matters familiar to the contemporaries of Hippocrates and Galen. But there are not a few articles in this dictionary of which even the headings would have been looked for in vain in a similar work as recently as fifty or sixty years ago. "Anæsthetics," "Ophthalmoscope," "Laryngoscope," "Microscope in Medicine," "Clinical Thermometry," "Physical Examination"—how great an increase in the useful power of medicine and surgery do these new titles represent! "Addison's Disease," "Lymphadenoma," "Leucocythemia," "Pernicious Anæmia," "Myxœdema," "Locomotor Ataxy," "Pseudo-hypertrophic Muscular Paralysis," "Diseases of the Spinal Cord," "Pneumogastric Nerve," "Sympathetic Nervous System"—how much is there here that is quite new and curious, and may one day be even useful! "Diphtheria," "Typhoid Fever," "Malignant Pustule," "Micrococci," "Bacilli," "Parasitic Skin Diseases," "Chyluria," "Thrombosis and Embolism," "Fatty Degeneration"—how much of progressive theory, better discrimination, and rational suggestion is contained in those! The headings "Antiseptic Treatment" and "Diseases of the Ovaries" will call to mind a degree of success in formidable surgical undertakings which no previous generation has known. It would be an endless task, and much too technical, to enter

into details about these numerous additions to the catalogue of diseases, to the stock of pathological ideas, and to the resources of treatment. The enumeration will serve to show that the alleged progress of medical science can be substantiated, if need be, by full particulars. It may be more generally interesting to give some account of the modern position of medical science—of its precision, and of what its precision depends upon.

PUBLICATIONS RECEIVED.

On the Characters of the Skull in the Hadrosauridæ; and on some Vertebrata from the Permian of Illinois. By E. D. Cope. Pp. 18, with Four Plates.

"Paleontological Bulletin," No. 36. First Addition to the Fauna of the Puerco-Eocene; On the Brains of the Eocene Mammalia Phenacodus and Periptychus; and Fourth Contribution to the History of the Permian Formation of Texas. By Professor E. D. Cope. Philadelphia: A. E. Foote.

Proceedings of the Third Annual Meeting of the Wisconsin Pharmaceutical Association held in Oshkosh, August 8–10, 1882. E. B. Holmstreet, Janesville, Secretary. Pp. 98.

Ætiology and Non-Infection of Sewer Gases. By Washington Ayer, M. D. San Francisco. 1883. Pp. 25.

Study of Neglected Lacerations of the Cervix Uteri and Perinæum. By Thomas A. Ashby, M. D. Baltimore, Md. Pp. 11.

The Nature of Heat and Gravity. By William Coutie. Troy, N. Y. 1883. Pp. 19.

Remarks on Hydrophobia. By Charles W. Dalles, M. D. Philadelphia. 1883. Pp. 12.

Third Annual Report of the Astronomer in Charge of the Horological and Thermometric Bureaus in the Observatory of Yale College, 1882–'83. By Leonard Waldo. New Haven. 1883. Pp. 20.

Acute Articular Rheumatism. By E. O. Bardwell, M. D. Emporium, Pa. 1883. Pp. 7.

The Newport Natural History Society. Document 1. Newport, R. I. 1883. Pp. 15.

Signal-Service Notes, No. 4, The Use of the Spectroscope in Meteorological Observations. By Winslow Upton, A. M. Pp. 7. No. 5, Work of the Signal-Service in the Arctic Regions. Pp. 40. Washington: Government Printing-Office. 1883.

Q. P. Indexes, No. XIII. An Index to Articles relating to History, Biography, Literature, Society, and Travel, contained in Collections of Essays. By W. M. Griswold, A. B. Bangor, U. S. A. Q. P. Index, Publisher. 1883. Pp. 56.

Pemphigus and the Diseases liable to be mistaken for it, pp. 11; Hints on the Treatment of some Parasitic Skin Diseases, pp. 11; The Treatment of Various Forms of Acne, pp. 7. By George H. Rohé, M. D. Baltimore, Md.

"The American Psychological Journal." Edited by Joseph Parrish, M. D. Quarterly. Vol. I, No. 2. July, 1883. Philadelphia: P. Blakiston, Son & Co. Pp. 112. $2 a year.

The Calendar of the Departments of Law, Science, and Literature of the University of Tokio, Japan. 1881–'82. Pp. 125.

Measurement of the Force of Gravity at Sapporo, Yesso. Published by the University of Tokio. 1882. Pp. 21.

Topics of the Time, No. 4. Historical Studies. Edited by Titus M. Coan. New York: G. P. Putnam's Sons. 1883. Pp. 205. 25 cents.

Hydraulic Tables for the Calculation of the Discharge through Sewers, Pipes, and Conduits. By P. J. Flynn, C. E. New York: D. Van Nostrand. 1883. Pp. 138. 50 cents.

Die körperlichen Eigenschaften der Japaner. Eine anthropologische Studie. (The Bodily Peculiarities of the Japanese. An Anthropological Study.) By Dr. Erwin Baelz. Yokohama: Press of the "Echo du Japon." Pp. 80.

Die Kupferlegirungen, ihre Darstellung und Verwendung bei den Volkern des Alterthums. (Copper Alloys, their Description and Application with the Peoples of Antiquity.) By Dr. E. Reyer. Vienna. Pp. 16.

Revista de Agricultura. (Review of Agriculture.) Nicomedes P. De Adan, Director. Monthly; August, 1883. Havana. Pp. 32.

Muster altitalienischer Leinenstickerei. (Pattern-Book of Old Italian Linen Embroidery.) Collected and edited by Frieda Lipperheide. Berlin: Franz Lipperheide. 2 vols. Pp. 32 and 36, with 22–30 Plates. 12 marks.

First Annual Report of the Board of Control of the New York State Experiment Station, for the Year 1882. Albany: Weed, Parsons & Co. 1883. Pp. 156.

Lessons in Qualitative Chemical Analysis. By Dr. F. Beilstein. St. Louis: St. Louis Stationery and Book Co. 1883. Pp. 164. $1.50.

Genesis. The Miracles and the Predictions according to Spiritism. By Allan Kardec. Boston: Colby & Rich. 1883. Pp. 488.

God and Creation. By Robert Reid Howison. Richmond: West, Johnson & Co. 1883. Pp. 573.

Photo-Micrographs and how to make them. By George M. Sternberg, M. D., F. R. M. S. Boston: James R. Osgood & Co. 1883. Pp. 204. Illustrated. $3.

Fifth Annual Report of the State Board of Health of Connecticut, for the Fiscal Year ending November 30, 1882. Hartford: Press of the Case, Lockwood & Brainard Co. 1883. Pp. 456. Illustrated.

POPULAR MISCELLANY.

The American Association.—The thirty-second annual meeting of the American Association for the Advancement of Science was opened at Minneapolis, Minnesota, August 15th, with the usual forms. The welcoming addresses were made by the Governor of the State, the mayor of the city, and Dr. Folwell, President of the State University, in whose halls the sessions were held. The address of the retiring president, Professor Dawson, was delivered in the evening, after which the members of the Association were entertained at a citizens' reception. Professor William A. Rogers, Vice-President of the Section of Mathematics and Astronomy, read an address on the "German Survey of the Northern Heavens." Professor H. A. Rowland, of Baltimore, Vice-President of the Physical Section, made "A Plea for Pure Science," in a paper which was marked by many strong thoughts. Professor Hitchcock, of the Geological and

Geographical Section, gave a review of the "Early History of the North American Continent." In the General Sciences, Professor E. D. Cope presented in a lecture "The Evidence for Evolution in the History of the Extinct Mammalia," and Dr. T. Sterry Hunt outlined "A Classification of the Natural Sciences." The Committee on Indexing the Literature of Chemical Elements reported progress to the Chemical Section. Among the other papers read in the various sections we notice that of Professor Holden, of Madison, Wisconsin, on the total solar eclipse of May 6, 1883, and Dr. Janssen's letter on the French observations of the same phenomenon. Mr. G. W. Hough, of Chicago, discussed some "Physical Phenomena on the Planet Jupiter." Mr. O. S. Wolcott, of Chicago, considered "Some Hitherto Undeveloped Properties of Squares." Professor W. A. Rogers continued from the Montreal meeting the subject of the determination of the relation between the imperial yard and the metre of the archives. Mr. F. E. Nipher, of St. Louis, gave an account of the magnetic survey of Missouri. The Signal Service received attention in a criticism of its operations and efficiency by Gustavus Heinrichs; in an account by Professor Mendenhall, of a method for the distribution of weather forecasts by means of emblems fixed upon railway-trains, which has been tried in Ohio; and in a plan for a State signal service, by Professor Nipher. Professor Macfarland, of Towanda, Pennsylvania, endeavored to show, in his paper on "The New Madrid Earthquake" of 1811, that the phenomenon was not an earthquake, but a subsidence of land which had been undermined by limestone caverns. Julius Pohlman, of Buffalo, presented a new view of the "Life History of Niagara River"; Professor Warren Upham read a paper on "The Minnesota Valley in the Ice Age." Much attention was given to topics bearing on agriculture, in the address of Professor Beal on that subject, and in papers by Professor Richardson on the composition of American wheat, of Professor Sturtevant on maize and sorghum kernels and on agricultural botany, and of Professor H. W. Wiley on American butter. Professor E. S. Morse gave an interesting account of the manner in which he had made use of the sun's rays for ventilating and partly warming his rooms, and presented papers on Japanese games and Eastern kitchens. Among the remaining papers we remark those of Elizur Wright on "Life-Insurance and Self-Insurance"; of Professor J. C. Arthur on a sea-weed of the Wisconsin lakes which produces poisonous effects at particular seasons; of T. R. Baker on terra-cotta lumber; of Professor Claypole on the potato-beetle and the Hessian fly; of Professor Riley on an insect exterminator; and observations on caverns, and on cyclones and tornadoes. We propose to publish abstracts or full reports in future numbers of such of these papers as may be of more general and popular interest. The next meeting of the Association was appointed to be held in Philadelphia. Dr. J. P. Lesley, of Philadelphia, was chosen President for the year, and sectional vice-presidents were appointed as follows: A (Mathematics and Astronomy), Professor H. T. Eddy, of Cincinnati; B (Physics), Professor John Trowbridge, of Cambridge; C (Chemistry), Professor J. W. Langley, of Ann Arbor; D (Mechanical Science), Professor H. B. Thurston, of Hoboken; E (Geology and Geography), Professor N. H. Winchell, of Minneapolis; F (Biology), Professor E. D. Cope, of Philadelphia; G (Histology and Microscopy), Professor T. G. Wormley, of Philadelphia; H (Anthropology), Professor E. S. Morse, of Salem; I (Economic Science and Statistics), Hon. John Eaton, of Washington. Permanent Secretary, Mr. F. W. Putnam, of Cambridge; General Secretary, Dr. Alfred Springer, of Cincinnati.

Dr. Harkness on the Nevada Footprints.—Dr. D. W. Harkness has contributed a paper to the San Francisco Academy of Sciences stating his reasons for maintaining, against the arguments of Professor Marsh and others, that the Carson (Nevada) "footprints" were made by a man, "*homo Nevadensis*," and not by a quadruped. The reasons are founded on the evidence given by the impressions that they were not made by a natural foot, but by one supplied with an artificial protection. Among the points of evidence adduced by Dr. Harkness is that the marks of the pads or cushions, with which the feet of all animals are provided,

and by which their foot-prints are distinguished, are wholly absent from the impressions. The absence of any evidence that the maker of the tracks had more than two feet is also insisted upon. "The curve of the foot is so regular and so constant as to show that in every instance the hind-foot —if of a quadruped—was at all times placed exactly upon the forward foot, or that both the forward and the hind feet were of exactly the same form—conditions which, to say the least, are extremely improbable." Evidence appears to be afforded in the shape of the tracks of one or two of the series that they were made by a yielding material which, like leather softened by moisture, gave way and was bent up at the sides. Unless something of this kind is admitted, the tracks must be believed to have been made by animals of different species. Other variations in the shapes of the tracks may be more readily accounted for by supposing them to have been made by sandals of different cuts than by quadrupeds having differently shaped feet. Dr. Harkness accounts for the width of the straddle, which has been urged against the human origin of the tracks, by suggesting that it would be one of the natural results of the exertion of walking in mud with the feet encumbered by such an unwieldy load as the enormous sandals.

Hygienic Qualities of Electric and Gas Lights.—Mr. B. H. Thwaite suggested, some years ago, that the intense heat developed in the arc electric light would produce a rearrangement in the gaseous contents of the atmosphere, by changing a mechanical combination into a chemical one, with the resultant development of deleterious nitrogen oxides. Mr. Wills, F. C. S., showed by experiment that ten to twelve grains of nitric acid were developed in an hour by the electric lamp. This rearrangement of gases is not produced in the incandescent lamps, for, besides the less development of heat, the filaments are kept in a vacuum. Hence, *per se*, the electric light of the incandescent type is hygienically satisfactory; but neither the incandescent nor the arc electric light assists vegetation. Besides the nitrogen oxides produced by the arc-light, says Mr. Thwaite, probably as much carbon dioxide is produced for the same illuminating power as is produced by the combustion of coal-gas. In both lights, the luminosity proceeds from the same cause—carbon heated to incandescence. The light produced by incandescent lamps is in almost perfect accord with the laws of visual or ocular hygiene, for it permits a choice of colors, but the arc-light is not so satisfactory, because it induces fatigue by its variations and its glare. The products of the combustion of coal-gas are aqueous vapor and carbon dioxide, with sulphuric acid resulting from the oxidation of the bisulphide of carbon contained in the gas. Besides these, nitrogen is set free from its mechanical combination with oxygen, but it is practically harmless. These gases may be removed by putting over the burners pipes for conveying them to the open air; and, if this were done, as it ought always to be done, the greatest disadvantage of the system of coal-gas lighting would be removed, and adequate ventilation would at the same time be provided. With regenerative burners, the intensity of combustion could be increased to such a degree that the light would be white and neutral, permitting colors of the most delicate hues to be easily distinguished. We should then have a light not only hygienically perfect, but, to the extent that it is utilized for assisting ventilation, superior in that respect to the best electric light.

Aëration of Peaty Water.—Professor W. N. Hartley and Mr. Gerard A. Kinchan, of Dublin, have made experiments with reference to the alleged power of aëration to purify the water of rivers from peaty matter they may have in solution, from which they are led to deny the existence of such power to any measurable extent. Their first experiment was made at the Powerscourt Fall of the Dargle River, where the water descends 360 feet vertically, and mostly in the form of spray. Here, if anywhere, aëration should have been general and effective; yet analyses of specimens from above and below the fall showed no variation in the amount of carbon beyond what could be attributed to experimental error. Next, samples of the water of Carawaystick Brook were taken, from distances 1,600 feet apart,

between which a fall of 700 feet took place. These specimens were likewise found to be nearly identical in composition, with neither the carbon nor the nitrogen diminished by the aëration consequent upon the fall. The introduction of mineral matters often produced very much greater effects than it was possible to show to be connected with aëration, and which varied in a considerable degree according to the nature of the matters added. From his experiments on this point, Professor Hartley derives the conclusion that the peaty coloring-matter in water "acts like an organic acid, and that it is probably a body of the type of alizarine or litmus, and is only slightly soluble, or is even insoluble in pure water, but is readily dissolved in water containing traces of alkali, or of soluble carbonate, such as ammonia or potash. With metallic oxides, iron and alumina, it forms insoluble compounds of the nature of lakes. Lime-water also precipitates it. Mineral acids, sulphuric, hydrochloric, and nitric, precipitate it. Peaty water may be perfectly bright and free from turbidity. These facts, and a further observation that subsidence will not clear a peaty water of its coloring-matter, lead to the conclusion that the coloring-matter is held in solution, and is precipitated as a lake, by various mineral bases." These conclusions are applicable to organic matter of a peaty character only.

Traits of Ancient American Civilization.—Max Steffer, in a recently published book on the "Agricultural Economy of the Civilized Ancient American Peoples," declares that it is really shameful to our boasted Caucasian superiority that European agency, instead of advancing the civilization of those nations, utterly destroyed it. The relics we have of them represent the vestiges of a civilization which in its way not only yielded nothing to that of the avaricious Spaniards, but in many respects surpassed it. They furnish evidences of a thorough systematic regulation of affairs, and of the cultivation of the soil by steady industry, with careful foresight and skilled practice. The Mexican people had secured an irrigation of the soil by means of canals without machines, to which the only counterparts in Spain were the works, not more ingenious, which the Moors had left; and the Spaniards betrayed their incapacity to appreciate the value of such constructions by allowing them to go to ruin, and sometimes destroying them in the expectation of finding golden water-pipes within them. The cultivation and irrigation of the soil were matters of public interest, and agriculture was placed under similar regulations to those which prevail in China and Japan. The division of the land and all changes in possession were made under the direction of the magistrates. Many conditions in the details of management were similar to those prevailing in Japan. Both people were without yoke-animals, and their estates were so small, and their manner of living such, that the employment of such animals was not necessary. The cultivation was rather that of the garden than of the field, and, as animals were not kept, the additional land they demand was not required. In the absence of domestic animals, minute and painstaking devices to get manure, like those prevailing in China, were adopted. The Peruvians enjoyed an advantage in having guano. Like the Eastern Asiatics, the ancient Americans also had no milk, although they possessed in the llama an animal that might have furnished them that aliment, with all its products.

Hints on Furnace-heating and Ventilation.—Mr. E. S. Philbrick, C. E., of Boston, has given some useful hints in "The Sanitary Engineer" on the management of heating apparatus and furnace-ventilation. If the air-box of the furnace is not opened after a wind subsides, if it is not open enough at any time, or, if, during windy weather, the air-box is not large enough to supply all the demand, the air is often taken by natural laws from one room down to the furnace and through it, to supply another room. The former room then becomes cooled off. In the last case the rooms on the windward side of the house are always the ones cooled, for it is hard to force the air into them from the hot-air pipes, unless an open fire is supplied to draw off the surplus pressure. Open fireplaces are efficient, generally, in promoting the comfort of the family, even if no fires are lighted in them. Air can not be induced to enter a tight room unless some

means of escape is given it, and the fireplaces furnish that. The course of the air entering the room from the heating apparatus is to rise to the ceiling and spread out there. It then descends along the sides of the room exposed to the open air, and is withdrawn by the fireplace if there is any which thus serves to facilitate the distribution of the heat in the lower part of the room. If the opening in the chimney is near the ceiling, the warm air will go out there without descending to the floor. It is important, in providing cold-air inlets for any kind of heating apparatus, to see that they take the air from a point where it is pure. They should also take it from the north or northwest, for the coldest winds come from that direction, and the heating of the house at such times is made much more convenient and safe if the prevailing draughts are made to assist it. If the inlets are on the south side of the house, the furnace is liable to be supplied, as is sometimes the case, with air from the northern rooms, entering the house through window-cracks or down a cold chimney, and sending the heated air out through the cold-air box into the back yard. There are limits, and they are not very wide, to the horizontal heating capacity of the best furnaces. Hence, if the ground-plan of the house is extensive, two or more furnaces should be provided rather than to depend upon one. Steam and hot-water apparatus are better horizontal distributors of heat than hot-air furnaces. As between the two, Mr. Philbrick prefers the hot-water apparatus as more easily managed, and more adjustable to mild temperatures, though its first cost is greater than that of steam apparatus. With either, the main dependence for heat should be upon air that has been heated by passing through the apparatus, rather than by direct radiation from pipes or surfaces in the rooms, which should be used only as auxiliaries.

Long Days and Plant-Growth. — The Norwegian plant-geographer, Schübeler, a short time ago called attention to some striking and surprising peculiarities manifested by vegetation in high latitudes, which he ascribed to the intensive light-effects of the long days. Most plants in these regions produce much larger and heavier seeds than in lower latitudes; and the difference is in some cases astonishing. Dwarf beans taken from Christiania to Drontheim gained more than sixty per cent in weight; and thyme from Lyons when planted at Drontheim showed a gain of seventy-one per cent. Grain is heavier in the north than in more southern latitudes; and Norwegian seed planted at Breslau fell off greatly in the first year. Another remarkable fact is that the increase of weight in northern latitudes takes place through the assimilation of non-nitrogenous substances, while the protein products have no part in it. The leaves also of most plants grow larger in high latitudes, and at the same time take on a deeper, darker color. This peculiarity, first noticed by Grisebach and Martins, has been observed not only in most of the wild trees and shrubs, but also in fruit-trees, and even in kitchen-garden plants. It has further been observed that the flowers of most plants are larger and more deeply colored, and that many flowers which are white in the south become in the far north violet.

Brain-Work under Pressure.—A writer in "The Journal of Science," on "Cram and its Amenities," only utters a truism when he remarks that brain-work is not *per se* physically injurious, but that, when kept within reasonable bounds and right conditions, it appears distinctly favorable to health and long life. He enforces the fact by some happy illustrations. An essential condition to the prosecution of brain-work without injury is that the organ must be sufficiently mature before it is subjected to much exertion; hence, it is disastrous to crowd the brains of children. Another important condition under which study is wholesome "is freedom from anxiety, hurry, and worry. This condition is admirably illustrated in the career of almost all great investigators of nature. Woehler (who died at eighty-two), for instance, contributed no fewer than two hundred and twenty-five memoirs to the scientific journals or to the transactions of learned societies. Almost all of these papers are of great value, and many of them embody the outcome of months of careful and delicate experimentation. But in no one case was he compelled to finish any of

these researches at a certain date, under appropriate pains and penalties. Precisely the same was the case with Darwin: he was able to pursue his inquiries calmly and dispassionately; able always to take two or three years, if his task could not be finished in one, and in no fear of unpleasant consequences if some idea which he had taken up should lead to nothing. But, if we say to a youth, or, worse still, to a child, 'You must, by a given date, reach a certain standard of knowledge, a certain grade of culture, to be judged of in a summary way . . .,' we place him in the very conditions wherein study becomes unsanitary, even ruinous, and that the more decidedly the more immature the brain." This is the tendency in hosts of schools, where everything is made to depend on examinations, the winning of honors at exhibitions, or on prizes and competitions.

Troubles of a Transfusionist in the Olden Time.—The "Union Médicale" quotes from an old book a curious story of the troubles which beset a physician who experimented in transfusion of blood in the seventeenth century. A Dr. Denys, of Rheims, a strong believer in transfusion, tried that remedy, using calf's blood, with great success, upon a young man whom he found mad in the streets. The patient recovered, and continued well for two months, when he relapsed into dementia. A second experiment worked improvement, but not a cure. The young man soon lost his senses entirely, and his wife brought him again to Denys. A new operation only increased the patient's pains, and he died in a few hours. The widow then brought suit against Denys for killing her husband, and the doctor brought a counter-action against the woman for trying to poison him. The suit went in favor of the woman, but was afterward carried, through a course of appeals, to the Parliament. The case seems ultimately to have been discharged, but an edict was issued forbidding the practice of transfusion, under pain of corporal punishment.

Fertilizers and Savages.—"To what extent is the use of agricultural fertilizers known among uncivilized people?" is one of the questions raised in a paper by Mr. G. Browne Goode, on "The Uses of Agricultural Fertilizers by the American Indians and the Early English Colonists." Mr. Goode finds clear evidence in his historical readings that the Indians of New England used and taught the early settlers to use the menhaden as a manure. The aboriginal name, *munnawhatteaug*, whence our menhaden is derived, means fertilizer, and another name, *paghaden*, is derived from a verb which means to enrich the land. Governor Bradford tells, in his "History of Plimouth Plantation," how the Indian Squanto taught the colonists in planting their corn, that, "excepte they got fish, and set with it (in these old grounds), it would come to nothing." George Mourt, in a journal published in 1622, in speaking of the planting, says, "According to the manner of Indians, we manured our ground with herrings, or rather shads." No other direct reference to its use by Indians is quoted, but several instances are found in which the employment by the colonists of fish for manure is mentioned. Dr. Rau has met with but one allusion to the use of fertilizers by uncivilized races. It is in the writings of Garcilasso de Vega, who mentions the use of guano by the Peruvians. Mr. H. H. Bancroft has found in a translation of the Quiche MS., by Brasseur de Bourbourg, a notice of the Maya custom of cutting and burning the growth on the corn-fields, and allowing the ashes to remain as manure. This, however, was accidental rather than intentional fertilization, as the main object of the burning was to clear away rubbish. Professor Atwater has learned that the Indians of the north shore of Lake Superior use white-fish and lake-trout in manuring their fields, and Mr. Dall says that the Indians of Alaska have learned a rude system of agriculture from the Russians.

NOTES.

H. C. Lewis and G. F. Wright have made a detailed study of the southern boundary of the glaciated area of Ohio, which they find to be sharply defined, though not everywhere marked by such a relative excess of moraine accumulation as in Long Island, New Jersey, and Pennsylvania. The line enters the State from the east in Columbiana County twelve miles north of the Ohio River, runs nearly west into Stark County, where it turns more to the south, and, continuing so to Knox County, it turns then at right angles to the south; thence south and south-

west to the Ohio River near Higginsport. "Cincinnati was completely enveloped by ice during the glacial period, and extensive glacial deposits exist in the northern part of Campbell and Boone Counties, Kentucky, and near Aurora, in Dearborn County, Indiana."

THE London "Academy" says that "a duel took place the other day at Pesth between two noblemen, one a son of Count Andrassy, which arose out of a quarrel about the truth of Darwanism. The supporter of Darwinism, we regret to hear, was seriously wounded." From which we may conclude that his opponent now believes in the doctrine of the "survival of the fittest."

DR. A. A. JULIEN, of Columbia College, in a paper on the "Decay of Building-Stones," read before the New York Academy of Science, remarked that the principle that stones are more lasting when laid "on bed" is demonstrated in all the varieties used in building. Defining "life" as the period during which the stone will present a decent appearance, he gave the following as the approximate duration of life of several kinds of stone in New York: Coarse brown-stone, best used out of the sun, from five to fifteen years; laminated fine brown-stone, twenty-five to fifty years; compact fine brown stone, one hundred to two hundred years; Nova Scotia stone, fifty to one hundred years; Ohio sand-stone, the best of the sand-stones, one hundred years; Caen stone, thirty-five to forty years; coarse dolomite marble, forty years; fine marble, sixty years; pure calcareous marble, fifty to one hundred years; granite, seventy-five to two hundred years, according to the variety. Some of the best kinds of building-stone have not yet been brought to the city.

MR. C. J. H. WOODBURY, of Boston, has had sent to him by the Société Industrielle de Mulhouse of Alsace, Germany, its silver prize medal, in recognition of his recent work on the best means of protecting cotton and woolen mills from fire. It is believed that this is the first time an American has been the recipient of this award.

PROFESSOR JOSEPH LE CONTE sums up the conclusions of a paper on the "Genesis of Metalliferous Veins," which is based on the examination of phenomena of metalliferous deposit by solfataric action in Nevada and California, by saying that "subterranean waters of any kind, but especially alkaline, at any temperature, but mostly hot, circulating in any direction, but mainly up-coming, and in any kind of water-way, but mainly in open fissures, by deposit form metalliferous veins. It is evident, therefore, that the form, appearance, and mode of occurrence of veins must be infinitely various, but the mode of formation is substantially one." The study of the varieties of formation may be important to the miner, but is of little value to science proper, except as it illustrates the one principle.

ONE of the finest crinoid beds in the world is at Crawfordsville, Indiana. It is more extensive and affords more perfect specimens than the bed at Keokuk, Iowa. Some of the specimens are twelve inches in length, and several have been sold for eight and ten dollars each. The fossils are imbedded in hard blue clay, and are so brittle that the work of removing them is exceedingly delicate and difficult.

A SUPPOSED stone implement has been found in Philadelphia, in a loose "water-gravel" twenty-four feet below the surface. It is an oblong rectangle in shape, sixteen and a half inches long, nearly four inches wide, and varies in thickness from half an inch at the sides to one and a half inch in the middle. Each extremity is ground to a smooth cutting edge. The specimen is of compact, yellowish-brown sandstone, and is the first that has been discovered in the Philadelphia gravel. If it should prove to belong to the gravel, and to be artificial, it will carry back the antiquity of man to glacial times.

SELECTIVE breeding of fish seems at hand. Seth Green has crossed the striped bass with shad, herring with shad, whitefish with salmon, salmon with brook-trout, and brook-trout with salmon-trout. The last cross is the most successful, and gives fine fish and good breeders. A cross between it and brook-trout promises to make a large trout, suitable for rivers and lakes. Mr. Green purposes next season to produce a seven-eighths brook-trout. He would try a cross between brook-trout and grayling provided both fish spawned at the same time of year, and has hopes of yet securing a cross between the grayling and the California mountain-trout, with which this condition is fulfilled.

CAPTAIN R. N. SCHUFELDT, of the Medical Corps, U. S. Army, has been making a scientific exploration of the vicinity of New Orleans, and has forwarded to the Smithsonian Institution a collection of some three thousand specimens of vertebrates and invertebrates of the region, together with the contents of an Indian shell-mound situated back of Carrollton. Among the vertebrates are some very uncommon forms of bats, and other rare species.

M. CH. MONTIGNY, of Brussels, has observed that the intensity of the scintillation of the stars is greatly increased during the presence of an aurora borealis, and that the increase is more marked in winter than in summer.

INDEX.

PAGE

Africa, German Explorations in 571
Agricultural Experimental Stations 596
Aims, Higher Professional 425
Air, Liquid, and Solid Alcohol 427
Allen, Dr. Nathan 433
Allen, Professor Grant 65
Americanitis 286
Andrew, Sallie L. 382
Animals, How much they know 39
Animals, Vegetating, and Symbiosis 811
Anthrax, Symptomatic, and Disinfectants 426
Armsby, H. P. 596
Association, The American 858
Astronomical News, Publication of 287
Astronomy, The Boundaries of 94, 239

Bad Lands, The Little Missouri 468, 634
Baerenbach, Friedrich von 195
Ball, Robert S., F. R. S. 94, 239
Bassett, Austin B. 553
Bathing, Suggestions about 718
Bayard, Edward, M. D. 732
Beard, Dr. George M. 137
Bell, Louis 536
Black, J. R. 698, 845
Blackwell, E., M. D. 388
Bond, A. Curtis 475
Books noticed:
"Animal Intelligence" (Romanes) 123
"Essays in Jurisprudence and Ethics" (Pollock) 125
"A History of the People of the United States" (McMaster) 125
"Pharmaceutische Rundschau" (Hoffmann) 127
"Whence, What, Where?" (Nichols) 127
"Bulletin of the Archæological Institute of America" (Greenleaf) ... 128
"Loess and Associated Deposits of Des Moines" (McGee and Call) ... 128
"Papilio" (Edwards) 128
"A Practical Treatise on Diseases of the Skin" (Duhring) 129
"A Dictionary of Electricity" (Greer) 129
"The Storage of Electricity" (Greer) 129
"On Prehistoric Trephining and Cranial Amulets" (Fletcher) 130

Books noticed:

PAGE

"The Naval Use of the Dynamo-Machine and Electric Light" (Murdock) 130
"The Sociologist" (Chavannes) 130
"Journal of Social Science" 131
"On the Value of the 'Nearctic,' as one of the Primary Zoölogical Regions" (Heilprin) 131
"Report of the Entomologist: Department of Agriculture" 131
"Bulletin of the Buffalo Naturalists' Field Club" 131
"Exploration of Parts of Wyoming, Idaho, and Montana" (Sheridan). 132
"The Place of Original Research in College Education" (Wright) 132
"A Study of the Manuscript Troano" (Thomas) 132
"The Elements of Forestry" (Hough) 133
"The American Journal of Forestry" (Hough) 133
"The Scientific and Technical Reader" 134
"Tables for Students and Beginners in Vegetable Histology" (Penhallow) 134
"Transactions of the Linnæan Society of New York" 134
"Ansichten über die Ursachen der Vulcane" (Reyer) 134
"Neptunisch oder Plutonisch?" (Reyer) 134
"The Foundation Principle of Education by the State" (Barnett) 134
"Forest Protection, and the Tariff on Lumber" 135
"Connecticut Agricultural Experiment Station. Report, 1882" 135
"Seed-Breeding" (Sturtevant) 135
"Development of Mineral, etc., Resources of Colorado for 1881 and 1882" (Smith) 135
"The Manual Training-School of Washington University, St. Louis" (Woodward) 135
"Dynamic Sociology" (Ward) 273
"Man before Metals" (Joly) 276
"On the Desert" (Field) 277
"Home Gymnastics and Swimming" (Hartelius) 278
"The Alternative" 279
"Idyls of Norway" (Boyesen) 279
"Aboriginal American Literature" (Brinton) 279
"Science in Short Chapters" (Williams) 279
"Diadem of School Songs" (Tillinghast) 280
"Conflict in Nature and Life" 416
"Our Home Physician" (Beard) 418
"Correspondence of Carlyle and Emerson" 418
"Examination of Medicinal Chemicals" (Hoffmann and Power) 419
"The Possibility of Not Dying" (Kirk) 420
"Bulletin of the United States Fish Commission" (1881) 420
"Electro-Magnets" (Du Moncel) 421
"A Perpetual Calendar" (Barnard) 421
"Pocket Logarithms" 421
"Report of the Bureau of Ethnology" (Smithsonian Institution) 421
"American Humorists" (Haweis) 422
"Jesus, his Opinions and Character" 422
"Introduction to the Study of Organic Chemistry" (Pinner) 422
"Entomological Papers, Iowa State Horticultural Society" (1882) 422

Books noticed: PAGE
"Manual of Assaying Gold, Silver, Copper, and Lead Ores" (Brown). 423
"Experiments with Kerosene on Insects of the Orange-Tree and Cotton-Plant" (Riley) 423
"Shade-Trees, Indigenous Shrubs, and Vines" (Stewart) 423
"Professional Papers of the Corps of Engineers of the United States Army" 423
"Astronomical Papers" (Newcomb) 423
"The Bacteria" (Burrill) 423
"The Q. P. Index Annual for 1882" 424
"Notes of Talks on Teaching" (Parker) 559
"Anniversary Address, Class of 1832, Union College" (West) 561
"The Life of James Clerk Maxwell" (Campbell and Garnett) 561
"Oliver Wendell Holmes, Poet, Littérateur, Scientist" (Kennedy) 561
"Methods of Social Reform," etc. (Jevons) 562
"Inquiries into Human Faculty and its Development" (Galton) 562
"Wealth-Creation" (Mongredien) 563
"Alcoholic Inebriety, from a Medical Stand-point" (Parrish) 563
"Catalogue of Publications of the Smithsonian Institution" (Rhees) 564
"The Leading Men of Japan" (Lanman) 564
"The Builder's Guide and Estimator's Price-Book" (Hodgson) 564
"First-Year Arithmetic-Teacher's Manual" (Hoose) 565
"Astronomy corrected" (Philbrook) 565
"Lowest Forms of Water Animals" (D'Anvers) 565
"Compendium of the Tenth Census" 565
"Geological Survey of New Jersey, 1882" (Cook) 565
"Report of the Chief Signal-Officer" (1880) 566
"The Jewelers' Circular and Horological Review" (Hopkinson) 566
"The Physiology of Protoplasmic Motion" (Englemann) 566
"Lectures to the Employés of the Baltimore and Ohio Railroad Company" (Martin, Sewell, Sedgwick, and Brooks) 567
"The Unending Genesis" (Simmons) 567
"Proceedings of the Davenport Academy of Sciences 567
"Proposed Ordinance, Rules and Regulations for Plumbing, in Philadelphia 567
"Appalachia," April, 1883 567
"Outline of Qualitative Analysis" (Stoddard) 568
"The Advanced Question-Book" (Southwick) 568
"Parish Institutions in Maryland" (Ingle) 568
"Old Maryland Manors," (Johnson) 568
"Life of Sir William E. Logan" (Harrington) 709
"On Work and Wages" (Brassey) 709
"The Religion of Humanity" (Frey) 710
"The Cause of Variation" (Curtis) 710
"Notes on Evolution and Christianity" (Yorke) 710
"Eve's Daughters" (Harland) 711
"Legal Provisions respecting the Examination and Licensing of Teachers 711
"Bacteria, and the Germ-Theory of Disease" (Gradle) 711
"School-Books on Physiology and Hygiene" (Chaillé) 712
"The American Trotting-Horse" (Brewer) 712

Books noticed:
PAGE
"Natural Cure of Consumption, Bright's Disease, etc." (Page)..... 712
"The Medico-Legal Journal"..... 712
"Van Loan's Catskill Mountain Guide"..... 713
"Political Economy" (Walker)..... 713
"Mastery"..... 713
"A Visit to Ceylon" (Haeckel)..... 713
"The Maintenance of Health" (Fothergill)..... 714
"Descriptive Sociology" (Spencer)..... 852
"Thermal Springs of the Yellowstone National Park" (Peale)..... 855
"The Diseases of the Liver" (Harley)..... 855
"American Museum of Natural History"..... 855
"Saxon Tithing-Men in America" (Adams)..... 856
"Medical Economy during the Middle Ages" (Fort)..... 856
"A Dictionary of Practical Medicine" (Quain)..... 856
Bosworth, R. S..... 409
Boundaries, The, of Astronomy..... 94, 239
Boyesen, H. H..... 237
Boys, C. Vernon, Esq..... 365
Brain-Health..... 572
Brain-Work, On, and Hand-Work..... 104
Brain-Work under Pressure..... 862
Bridge, The East River, Constructive Elements of..... 385
Bridge, The Great, and its Lessons..... 339
Buchner, Max..... 399
Burial, A Premature..... 143
Burmese Animal Life..... 142
Buttercup, From, to Monk's-hood..... 65

Cahall, W. C., M. D..... 86
Campbell, Cl. T..... 700
Carpenter, F. D. Y..... 453
Cat-Lore..... 573
Catskill Mountain-Tops, Vegetation of the..... 283
Chambers, Prehistoric Underground..... 570
Channing, W. F., M. D..... 540
Chase, Pliny Earle..... 268
Cheesman, James..... 354
Chemistry and Pharmacy..... 46
Civilization, Traits of Ancient American..... 861
Clothing and the Atmosphere..... 787
Cities, Ancient, in Guatemala..... 428
Coal, How the Ancient Forests became..... 56
Cod-Mountain, A, in the Sea..... 715
Coins, Antique, Baron Stjerstedt's..... 282
Color-Blindness, Some Peculiarities of..... 573
Colors, Association of, with Sounds..... 490
Combustion, Spontaneous..... 716
Constitutions, Written and Unwritten..... 267
Consumptives, Florida as a Health Resort for..... 114
Cookery, The Chemistry of..... 214, 373, 509, 586, 818

PAGE

Copernicus, Darwin and 249
Copyright in China 715
Corona, Photographing the 285
Correction, A Homœopathic 700
Correspondence 114, 267, 408, 552, 698, 845
Criticism, A 698
Cyclones and Tornadoes 748

Darwin and Copernicus 249
"Data of Ethics," the, A German View of 195
Dawson, Dr. J. W 827
De Chaumont, Professor, M. D., F. R. S 658
Deep-Sea, A Wonder from the 75
Deformities due to School-Life 572
De Parville, Henri 490
De Saporta, M. G 56, 673, 753
Descent, Perrier on the Theory of 524
Disease, The Germ-Theory of 577
Dix, Dr., on the Woman Question 120
Dix, Dr., The Back-down of 409
Dog, a Superstitious 63
Drunkards? our, What shall we do with 140
Du Bois-Reymond, E 249
Duncan, John, the Weaver-Botanist 717
Dyer, T. F. Thiselton 251
Dyspepsia 141

Earth, How the, was Peopled 673, 753
Earth-Tremors 430
Eclipse, The Solar, of May, 1883 140
Editor's Table 116, 268, 409, 554, 701, 849
Education, Technical 475
Electric and Gas Lights, Hygienic Qualities of 860
Elephant, The, Mental Capacity of 497
Elephants, Intelligence shown by 848
English, Teaching 553
Espinas, M. A 524
Evolution 237
Examinations, Cram 285

Faculæ and Sun-Spots 642
Fangs, False, in Harmless Snakes 431
Farr, Dr. William, Sketch of 404
Fernald, F. A 39, 385
Fire-proof Building Construction 613
Fisheries of New York 427
Fishes, Musical 571
Florida as a Health Resort for Consumptives 114
Flowers, The Colors of 837
Food, Ways of Preserving 623
Foot-Prints, the Nevada, Dr. Harkness on 859

PAGE
Forests, North American, The Geological Distribution of 517
Frauenstein, Georg M..... 682
Funerals, Chiriqui..... 716
Funerals, Scotch, in the Olden Time..... 141
Funeral-Wreaths, Egyptian, restored..... 284
Furnace, A Smoke-consuming 717
Furnace-heating and Ventilation, Hints on..... 861

Geology, Some Unsolved Problems in..... 827
Germ-Theory, The, of Disease..... 577
Gest, J. Henry..... 527
Götz, Johannes..... 88
Gradle, Professor H., M. D..... 577
Grain-growing, Selection in 354
Greek and Latin against Nature and Science..... 116
Guatemala, Ancient Cities in..... 428
Gymnastics..... 77

Halsted, Byron D., Sc. D..... 741
Harkness, Dr., on the Nevada Foot-Prints 859
Herbert Spencer and the French Academy..... 554
Hewitt, Abram S..... 339
Highway, the Suspended, Opening Day of..... 411
History, Unwritten..... 317
Holmes, Dr., The Banquet to..... 272
Homœopathy and Quackery..... 847
Homœopathy as a Science..... 732
Hornaday, William T..... 497
Howell, Thomas J..... 517
How much Animals know 39
Huxley, Professor T. H..... 317
Hygienic Science, The Growth of 658

Iles, George..... 289
Indians, Brazilian, Capacity of..... 716
Insanity..... 627
Insanity, The Prevention of..... 139
Instinct, Developing a New..... 552
Instincts, Some Newly Remarked..... 719
Insurance Management, Improvements in 143
Investigations, Thermo-Chemical, The Aim of..... 770

Jacobi, Abraham, M. D..... 773
Jostrow, Joseph 849

King, A. F. A., M. D..... 644
Krätzer, Dr. Hermann..... 623

Lamb, R., C. E..... 54
Lente, Frederick D., M. D..... 114
Le Sueur, W. D., B. A..... 444

PAGE

Letter, An Intercepted 115
Life, Cost of 202, 409
Life, Microscopic, in the Air 28
Lightning-Rods 429
Literary Notices 123, 273, 416, 559, 709, 852
Liver-Fluke, The, of Sheep 741
Locusts as Food for Man 531
Logan, Sir William, LL. D., F. G. S., Sketch of 691
Lovett, Robert W 362
Lunt, Horace 669
Lyle, David A., U. S. A 531

McBride, Professor T. H 468, 634
McBride, R. W 701
McFarland, R. W 409
McGloin, Frank 553
Magnetic Storms and Sun-Spots, Recent 163
Malaria, Mosquitoes and 644
Man, Fossil, in America 137
Map-making, Primitive 682
Marriage and Divorce Laws, Our 224, 668, 701
Matter, Living and Not-Living 721
Measures, English and Metric 431
Medical Quacks and Quackeries 145
Mello, Rev. J. Magens, F. G. S 180
Mendenhall, Professor T. C 20
Merrick, E. T 663
Meters for Power and Electricity 365
Microscopy as a Science 575
Monk's-hood, From Buttercup to 65
Moraine, The Glacial, in Pennsylvania 425
Mortality in London and New York, Curves of 717
Mosquitoes and Malaria 644
Mythology, Our Indian 527

Nationalities in New York City 569
Natural History, The New York State Museum of 139
Nature, The Remedies of 1, 187, 303, 477, 604, 760
New England Population, Changes in 433
Newton, Heber, and the Heresy-Hunters 271
New York City, Nationalities in 569
Niagara Falls as a State Park 140
Notes 144, 287, 431, 575, 720, 863
Nursing, Modern, The Historical Development of 778

Olivier, Louis 28
One who has been Insane 627
Oswald, Felix L., M. D 1, 187, 303, 477, 604, 699, 760
Owen, Professor Richard, F. R. S., Sketch of 109

Patterson, J. S 553

PAGE
Perrier on the Theory of Descent 524
Perry, Professor Thomas Sergeant 13
Pettenkofer, Max von, Sketch of 841
Pharmacy, Chemistry and 46
Physics in General Education 20
Plant-Growth, Long Days and 862
Plants, Insectivorous 382
Pluto, The Case of the Dog 553
Politics, Modern, The Anarchy of 444
Popular Miscellany 137, 281, 425, 569, 715, 858
Population, New England, Changes in 433
Portrait, The First Daguerrean 188
Pratt, John 202
Prehistoric Underground Chambers 570
Progress and the Home 412
Psychology, African 399
Publications Received 136, 280, 424, 568, 714, 858
Putnam, Joseph Duncan 425

Quartz, its Varieties and Formation 180
Quackery, Concerning 850

Radau, M. R. 787
Radiation, On 456
Railroad Problem, The, in the United States 289
Rank and Title 453
Reclamation 268
Reis, Philipp, Sketch of 540
Remedies, The, of Nature 1, 187, 303, 477, 604, 760
Remsen, Professor Ira 46
Reply, Dr. Oswald's 699
Rest, The Right to 285
Revenge, Animal 283
Rhine, Alice Hyneman 408
Ricker, C. J., M. D. 847
Right-Handed? Why are we 86
Ringueberg, Eugene N. S. 63
R. M. N. 104
Room enough in the World yet 286

Savages, Fertilizers and 863
Savings, The, of Science 798
Scholarships, The Tyndall 412
School-Life, Deformities due to 572
Schools and Infectious Diseases 429
School-Sessions, Too Long 429
Science and Conscience 13
Science and Faith 281
Science, Literature, and Theology 268
Science. Meeting of the American Association for the Advancement of Science at Minneapolis 849

PAGE

Science-Teaching, On, in the Public Schools..... 207
Scruples, Religious, Satisfying..... 718
Sea-Sickness, The Cause of..... 362
Sea-Wall, A Natural..... 536
Sea-Waves, The Formation of..... 492
Sedgwick, W. T., Ph. D..... 811
Serviss, Garrett P..... 163
Sewage at the Sea-Side..... 408
Sheep, The Liver-Fluke of..... 741
Shepherd, Dr. F. J..... 145
Shipman, Paul R..... 721
Silliman, Professor Benjamin, LL. D., Sketch of..... 259
Simmonds, P. L..... 798
Smell, Insect Organs of..... 284
Smith, George Clinton..... 748
Smith, Henry A..... 642
Smith, P. C..... 552
Solar Rays, Machines driven by..... 337
Sorel, Émile..... 492
Sounds, Association of Colors with..... 490, 848
Spectrum, the Visible, Lengthening..... 88
Spencer, Herbert, and the French Academy..... 554
Spring, M. W..... 68
Stammering, Treatment of..... 138
Starch, The Granule of..... 687
Stewart, Gordon A..... 224
Stout, H. R., M. D..... 848
Street, Charles R..... 267
Superstition, The Dead-Language..... 701
Swimming, Position and Stroke in..... 54
Symbiosis and "Vegetating Animals"..... 811

Teaching English..... 553
Telephone, The, with a Sketch of its Inventor, Philipp Reis..... 540
Tin-Ware, Action of Acids on..... 571
Thermo-Chemical Investigations, The Aim of..... 770
Thomsen, Julius..... 770
Tissandier, G..... 337
Tobacco Smoke, The Poisons in..... 427
Tornadoes, Cyclones and..... 748
Tornado, How to act in a..... 281
Tracks, Human, More Supposed Pre-Glacial..... 846
Transfusionist, Troubles of a..... 863
Trees, The Age of..... 552
Tyndall, Professor John, F. R. S..... 456

Vaillant, M. L..... 75
Vapor, Influence of, on Radiation..... 287
Vital Phenomena, Two, Explained..... 575
Vivisection in the State of New York..... 169
Vogel, August..... 837

PAGE
Ward, W. E. 618
Water, Aëration of Peaty 860
Water, Getting, in the Desert 428
Water, On the Colors of 6
Weddings, Bedouin 574
Whistling 251
Wilder, B. G., M. D 160
Williams, W. Mattieu 214, 373, 509, 586, 818
Wöhler and "Vital Energy" 553
Woman Question, Dr. Dix on the 120
Women, The Industrial Position of 388
Wonder, A, from the Deep-Sea 75
Woodland and Water-Course 669
Worcester, Alfred, A. M 77

END OF VOL. XXIII.

PAGE
Ward, W. E. 618
Water, Aëration of Peaty 860
Water, Getting, in the Desert 426
Water, On the Colors of 6
Weddings, Bedouin 574
Whistling 251
Wilder, B. G., M. D. 169
Williams, W. Mattieu 214, 373, 509, 586, 818
Wöhler and "Vital Energy" 553
Woman Question, Dr. Dix on the 120
Women, The Industrial Position of 388
Wonder, A, from the Deep-Sea 75
Woodland and Water-Course 669
Worcester, Alfred, A. M. 77

END OF VOL. XXIII.